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(54) **ADAPTER, EXTENSION, AND CONNECTOR ASSEMBLIES FOR SURGICAL DEVICES**

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See application file for complete search history.

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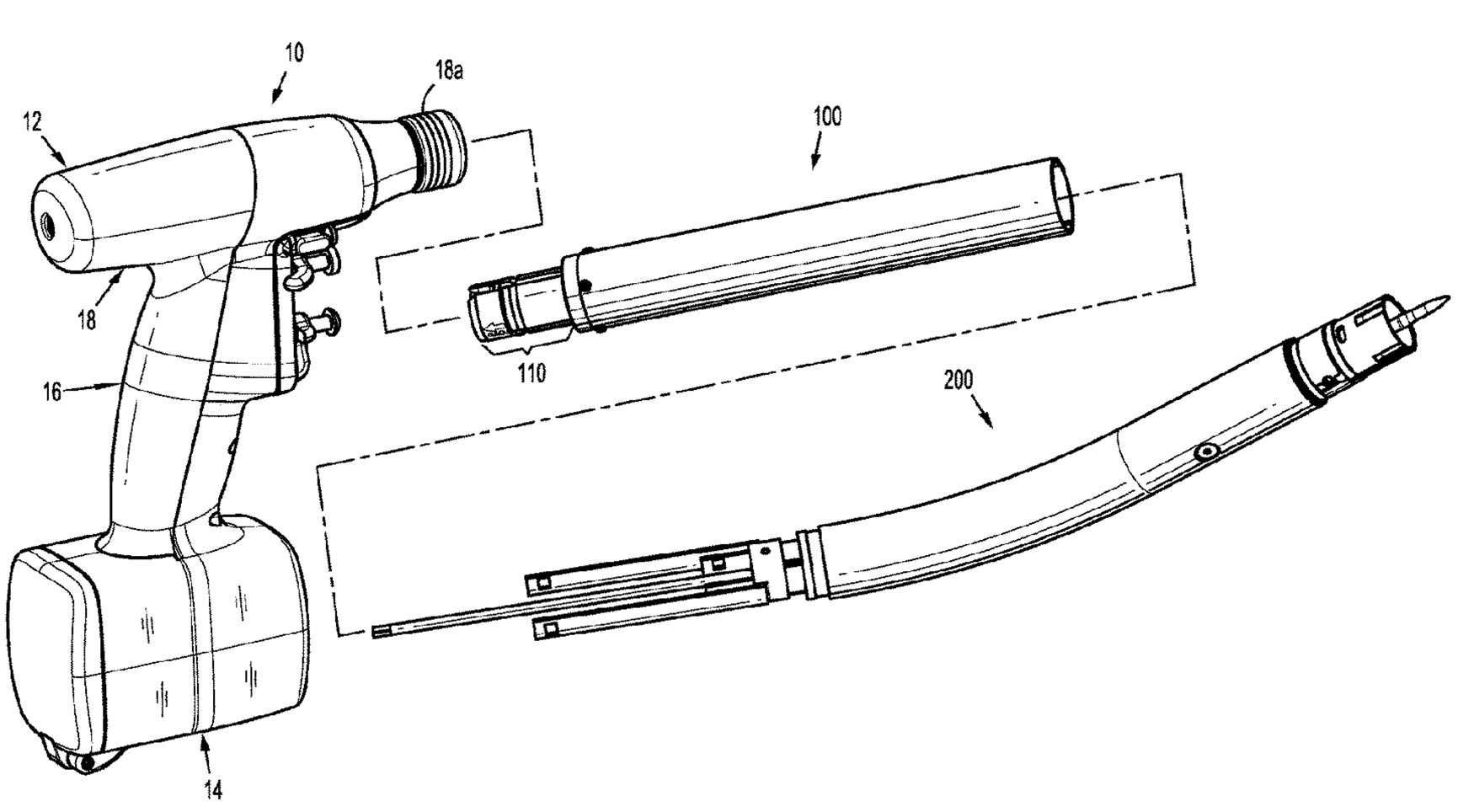
(57) **ABSTRACT**

An assembly including an adapter assembly and an extension assembly for connecting an end effector to an electrosurgical instrument is provided. The adapter assembly includes a first pusher assembly configured for converting rotational motion into linear motion. The first pusher assembly includes a pusher member and first and second pawl assemblies for operable engagement with a flexible band assembly of the extension assembly.

18 Claims, 29 Drawing Sheets



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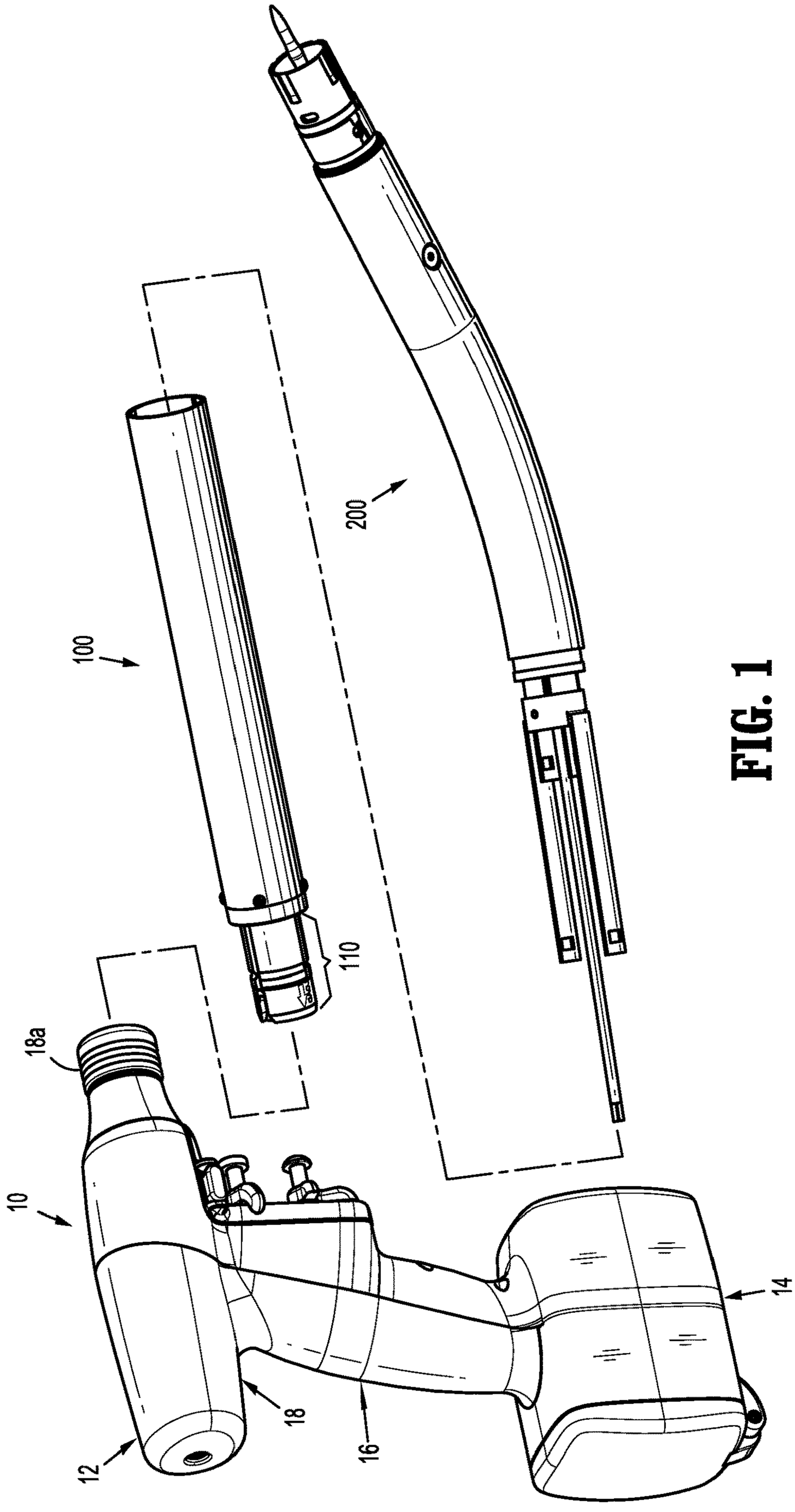

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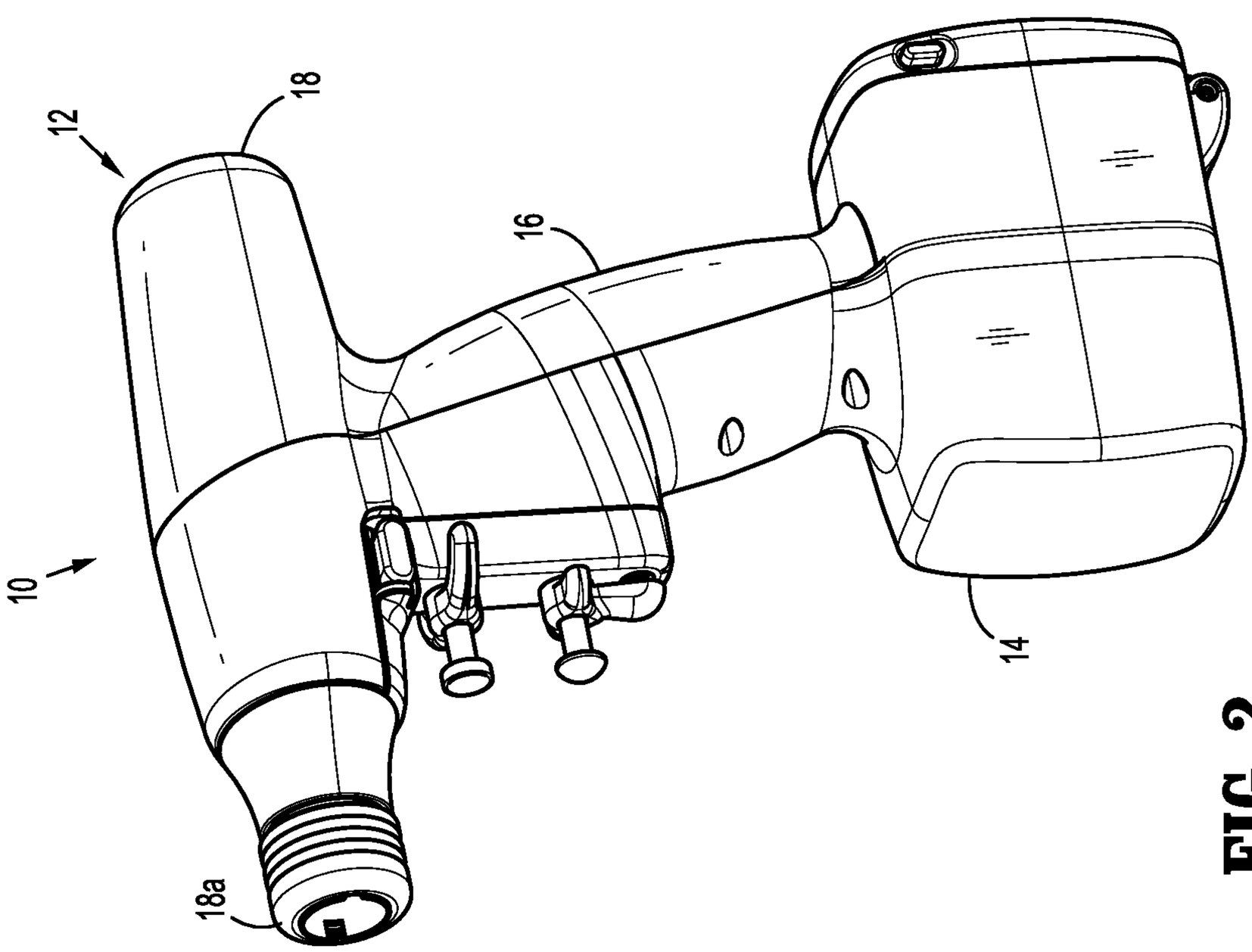

FIG. 2

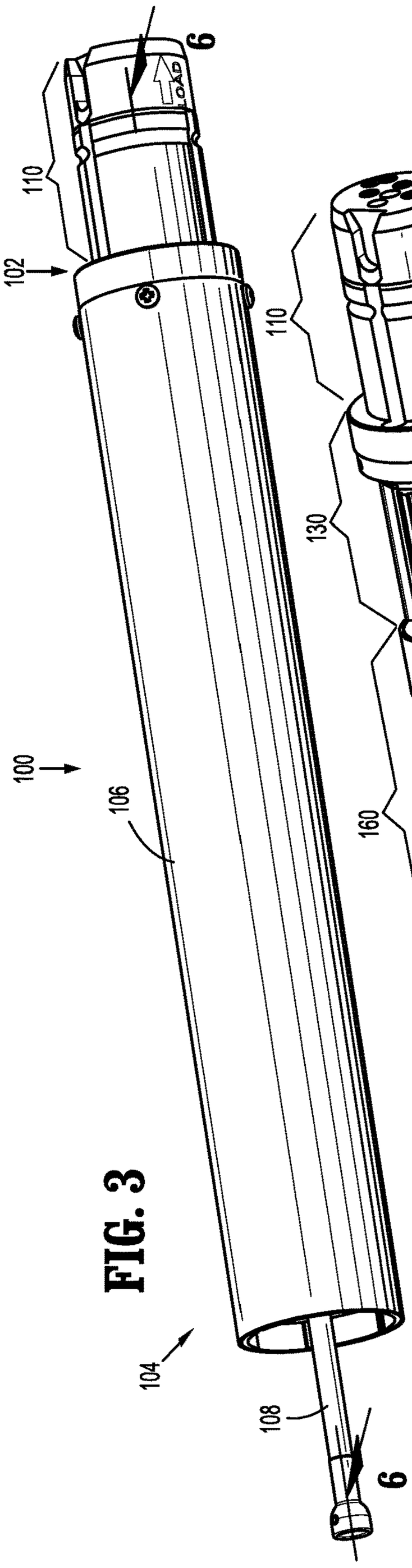

FIG. 3

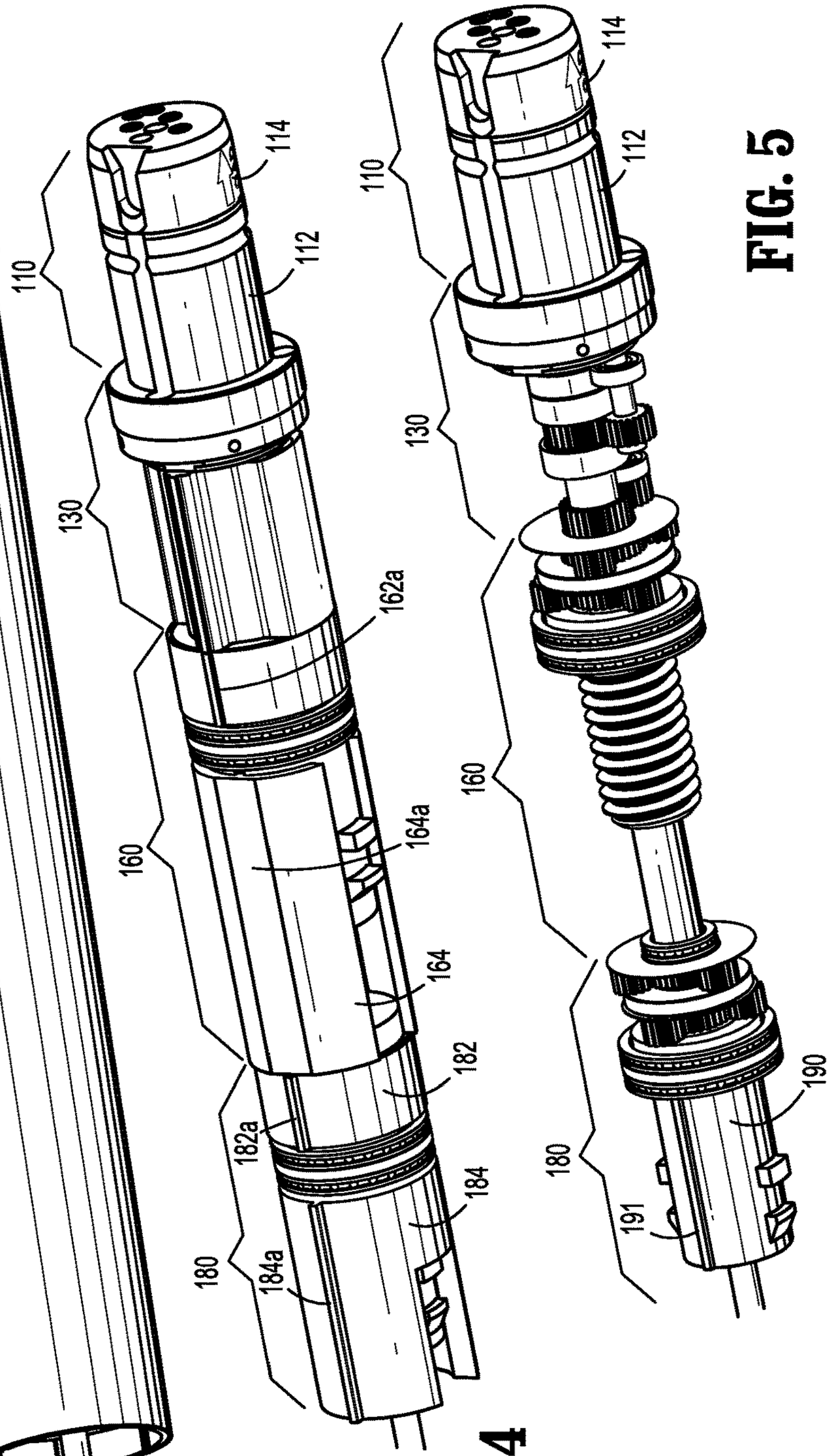

FIG. 4

FIG. 5

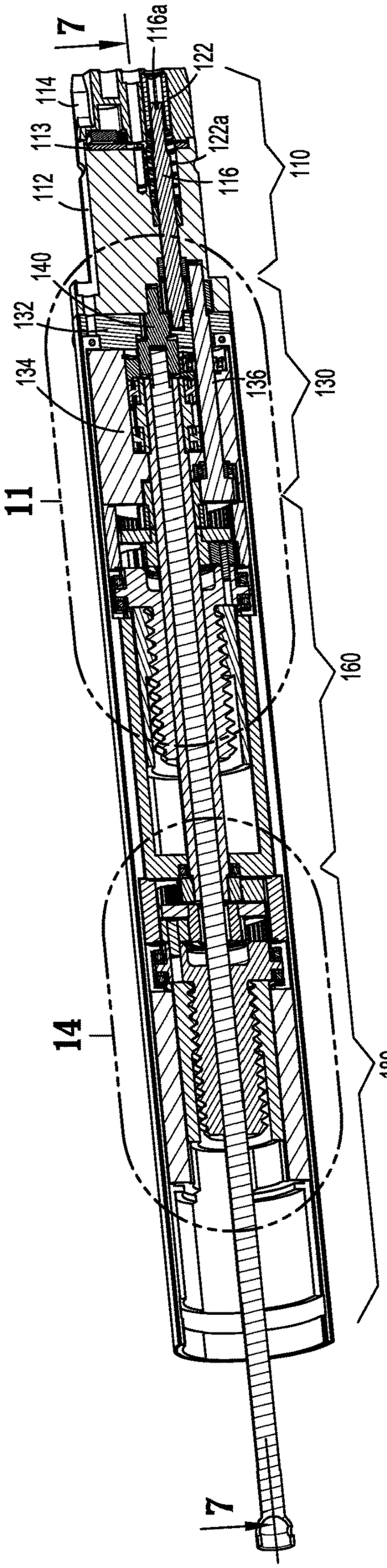
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FIG. 6

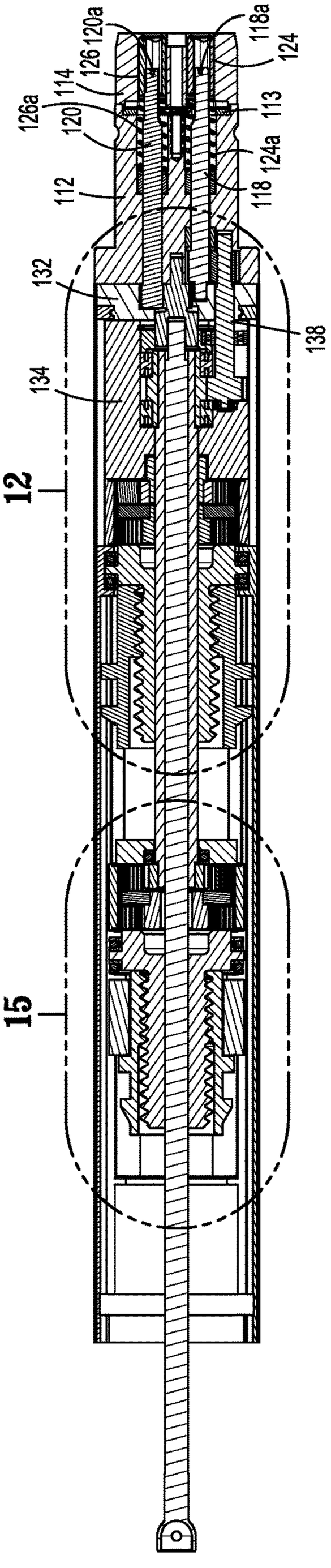
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FIG. 7

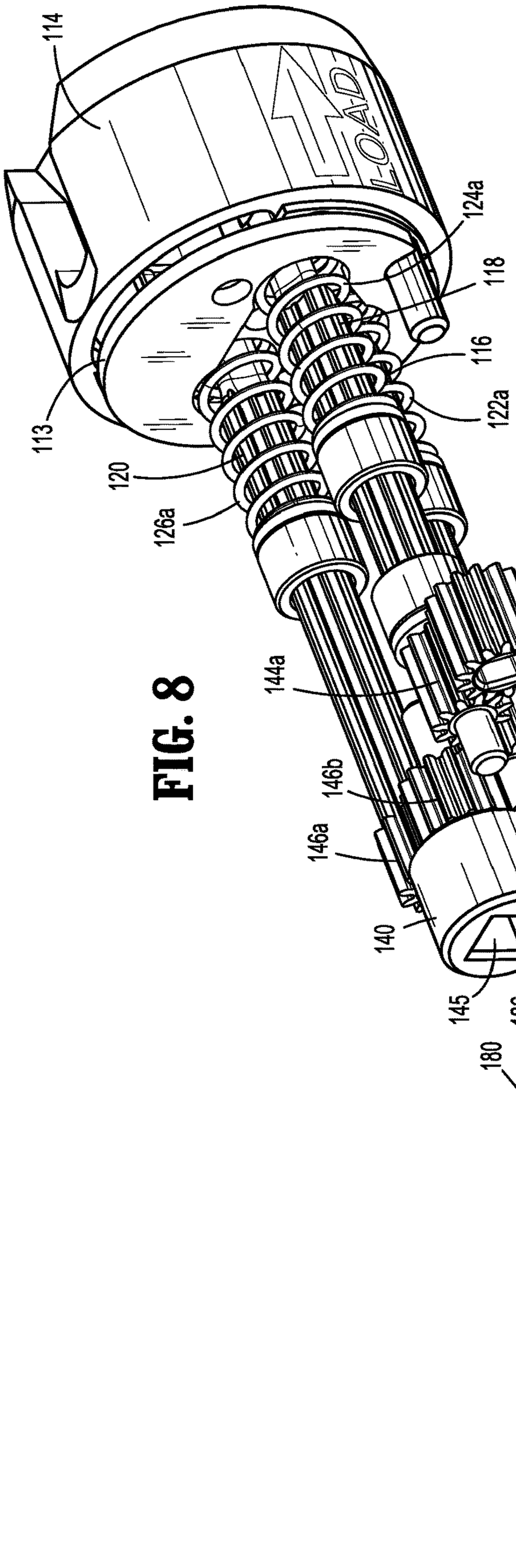
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FIG. 8

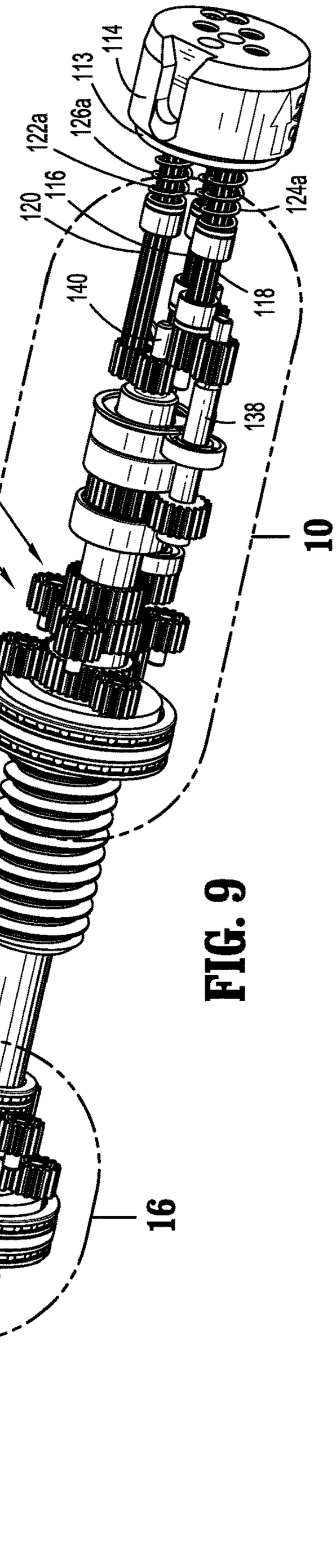
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FIG. 9

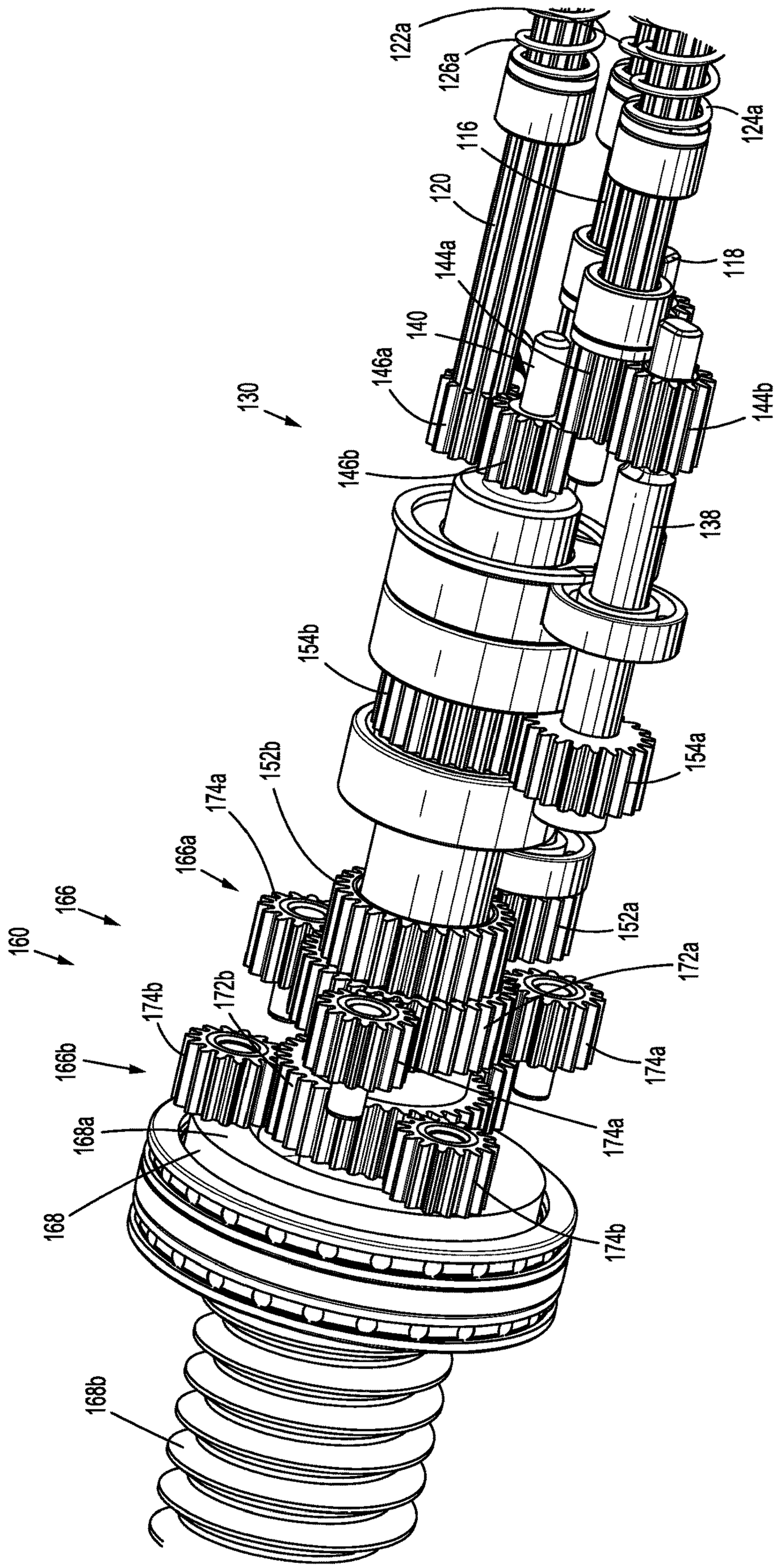
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FIG. 10

FIG. 11

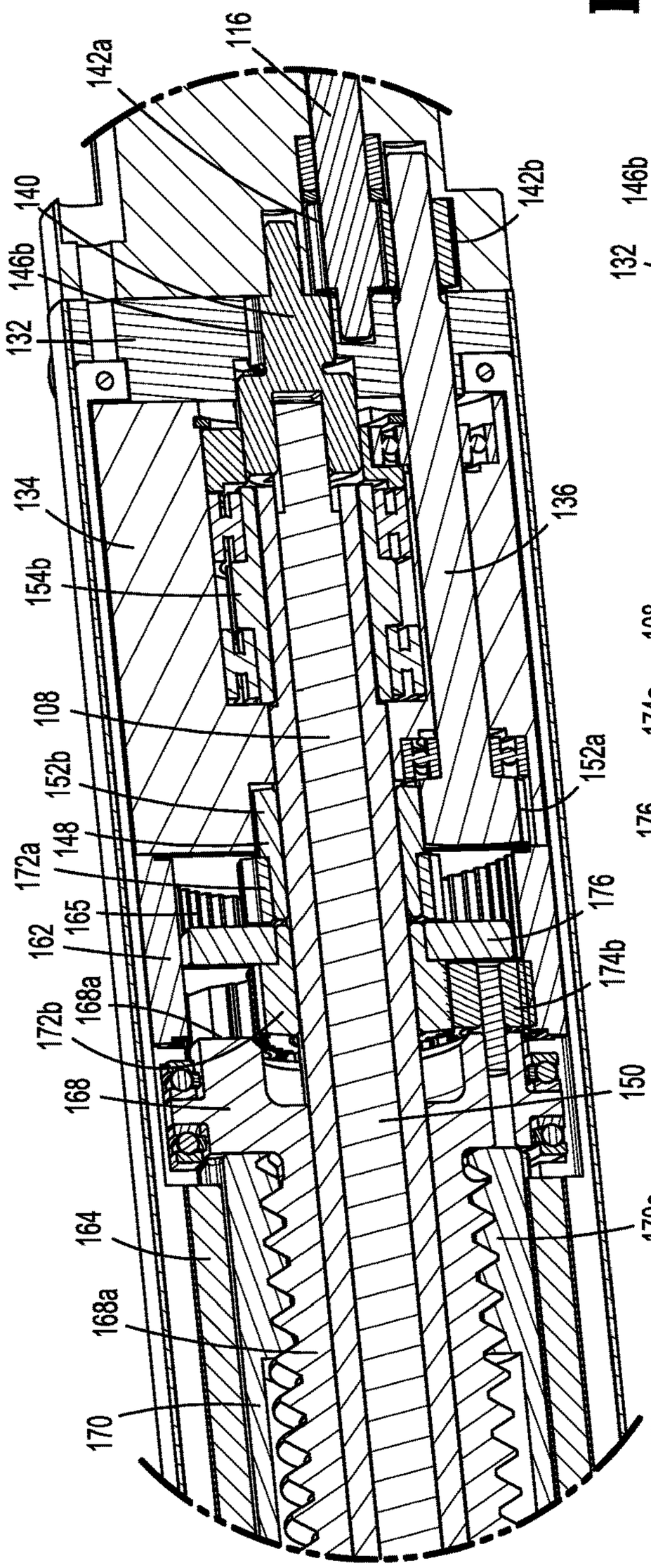
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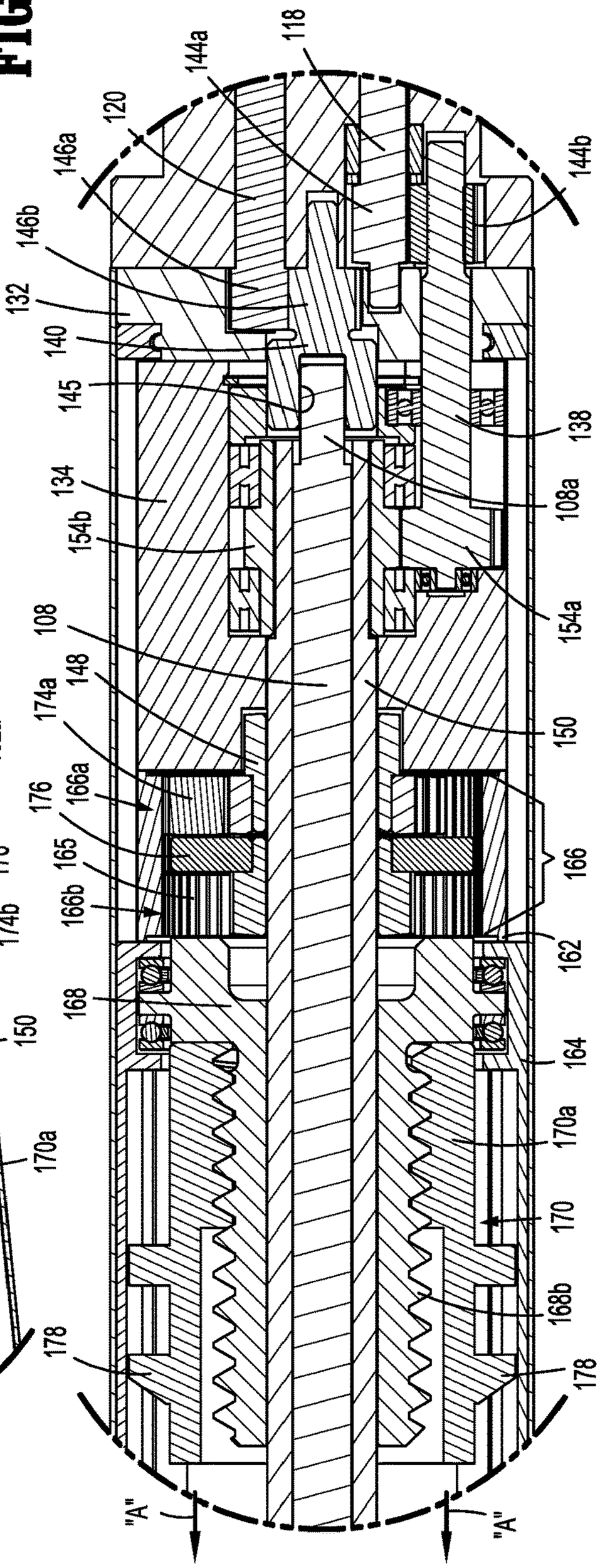
FIG. 12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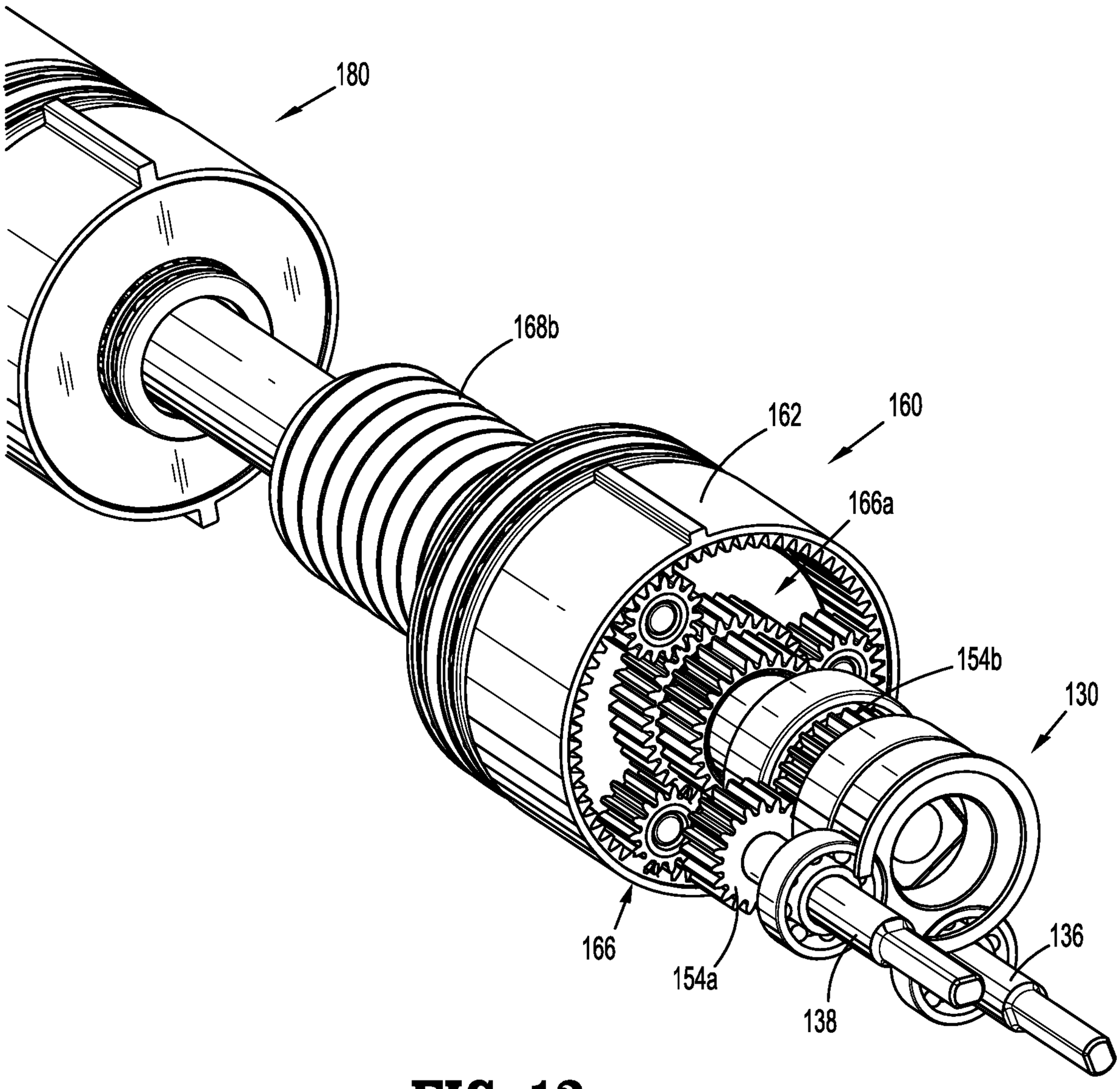

FIG. 13

FIG. 14

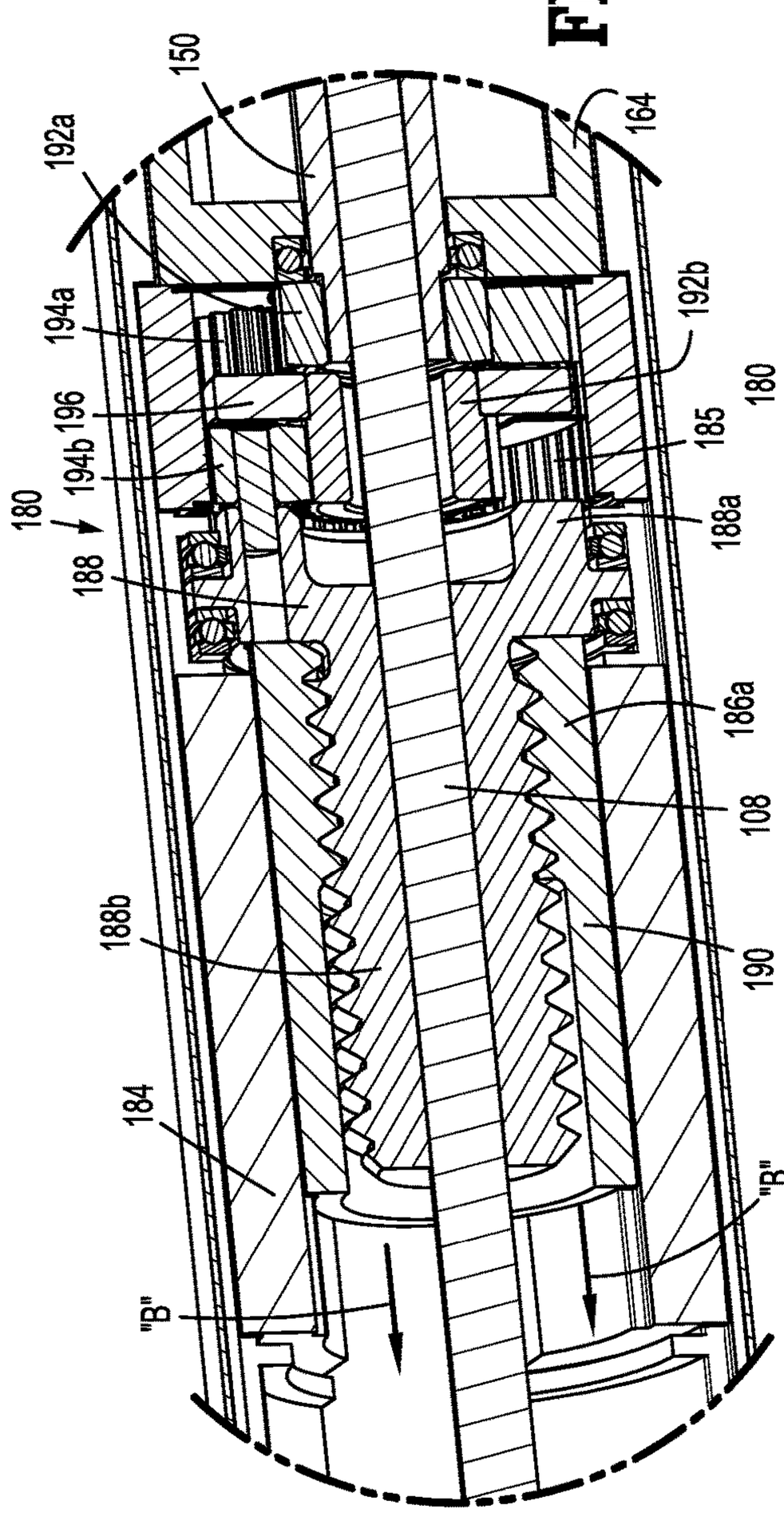
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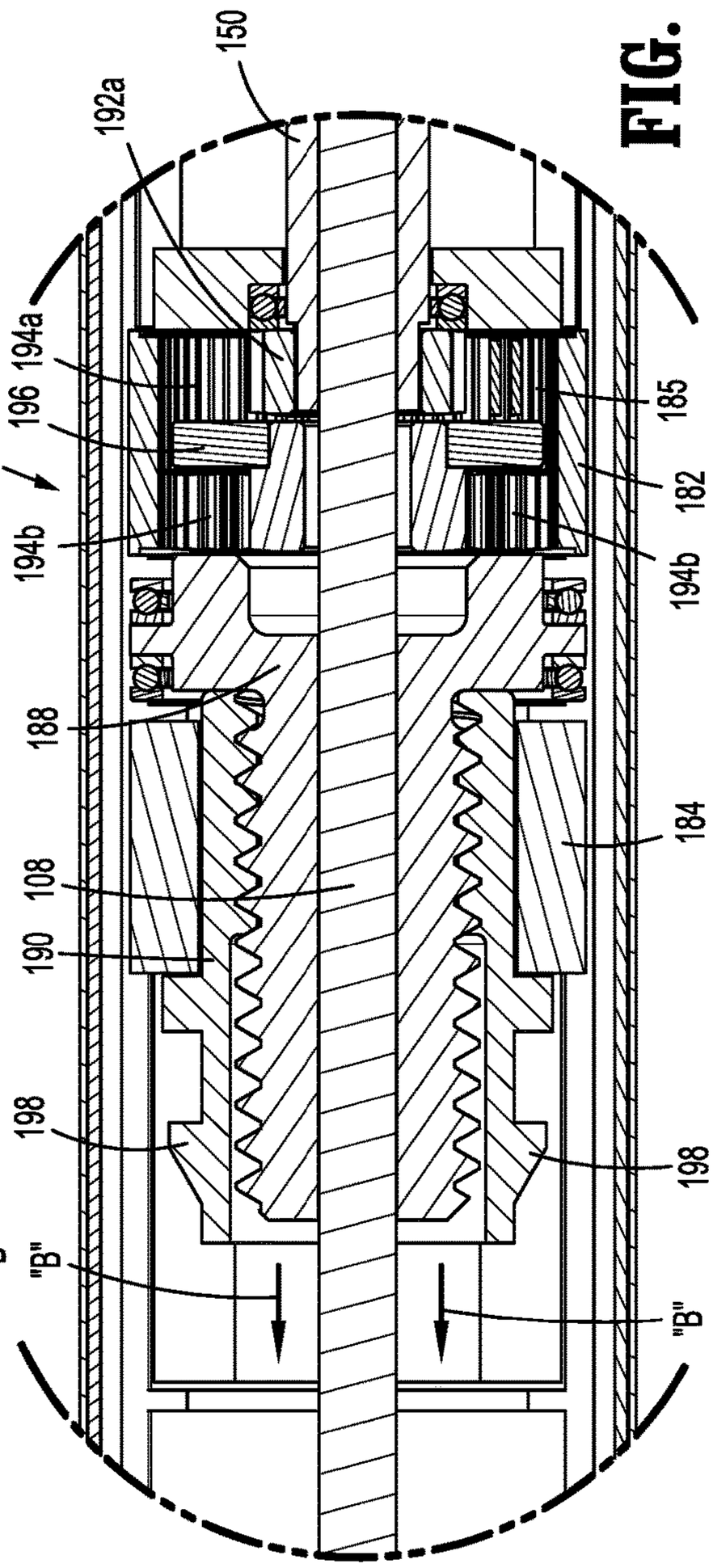
FIG. 15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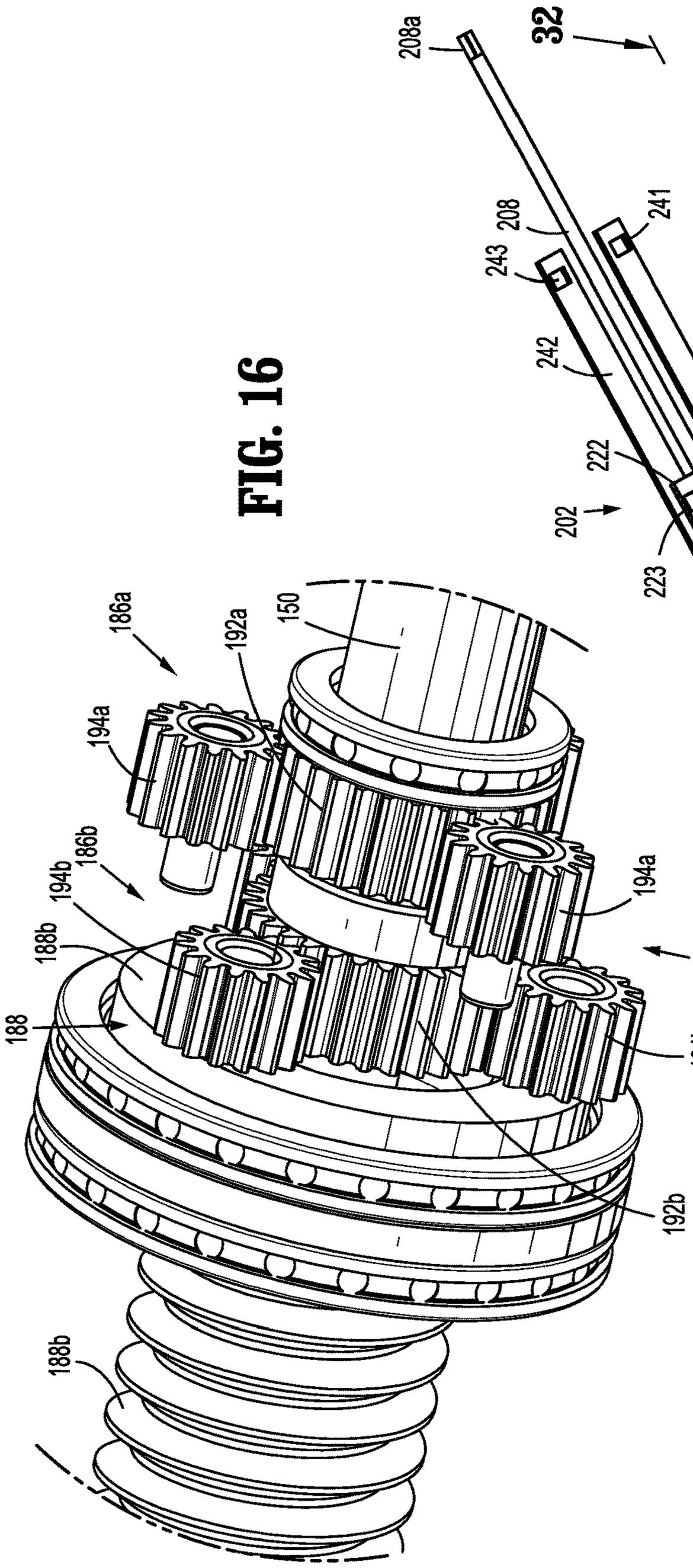
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FIG. 16

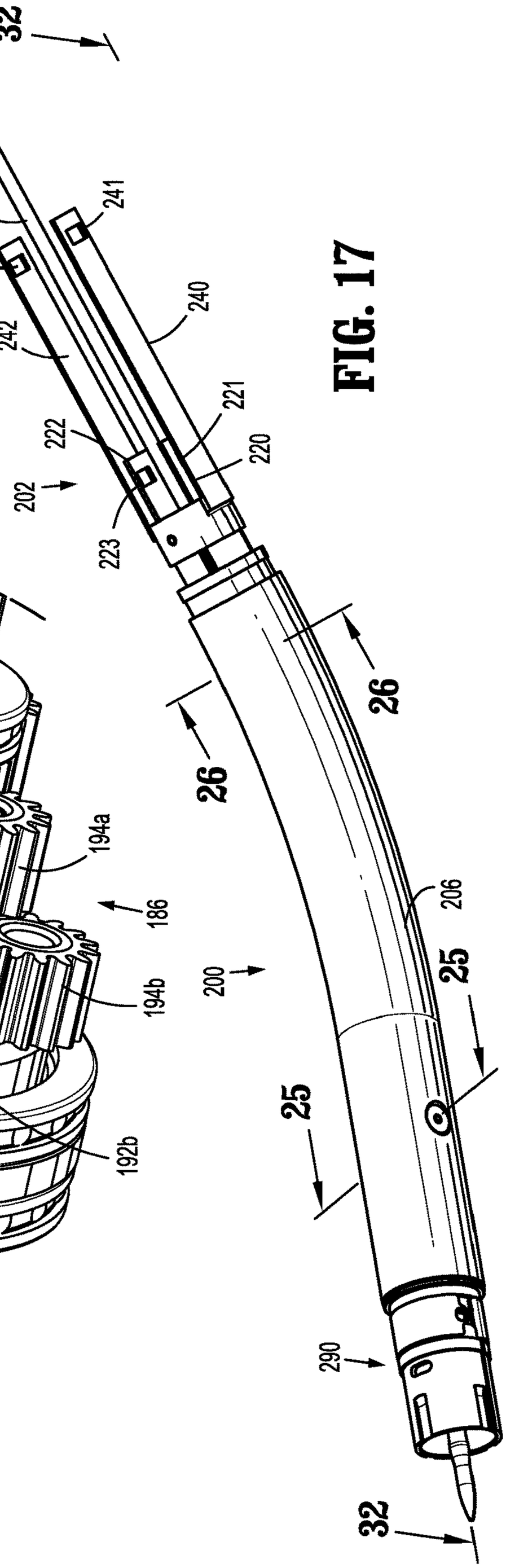
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FIG. 17

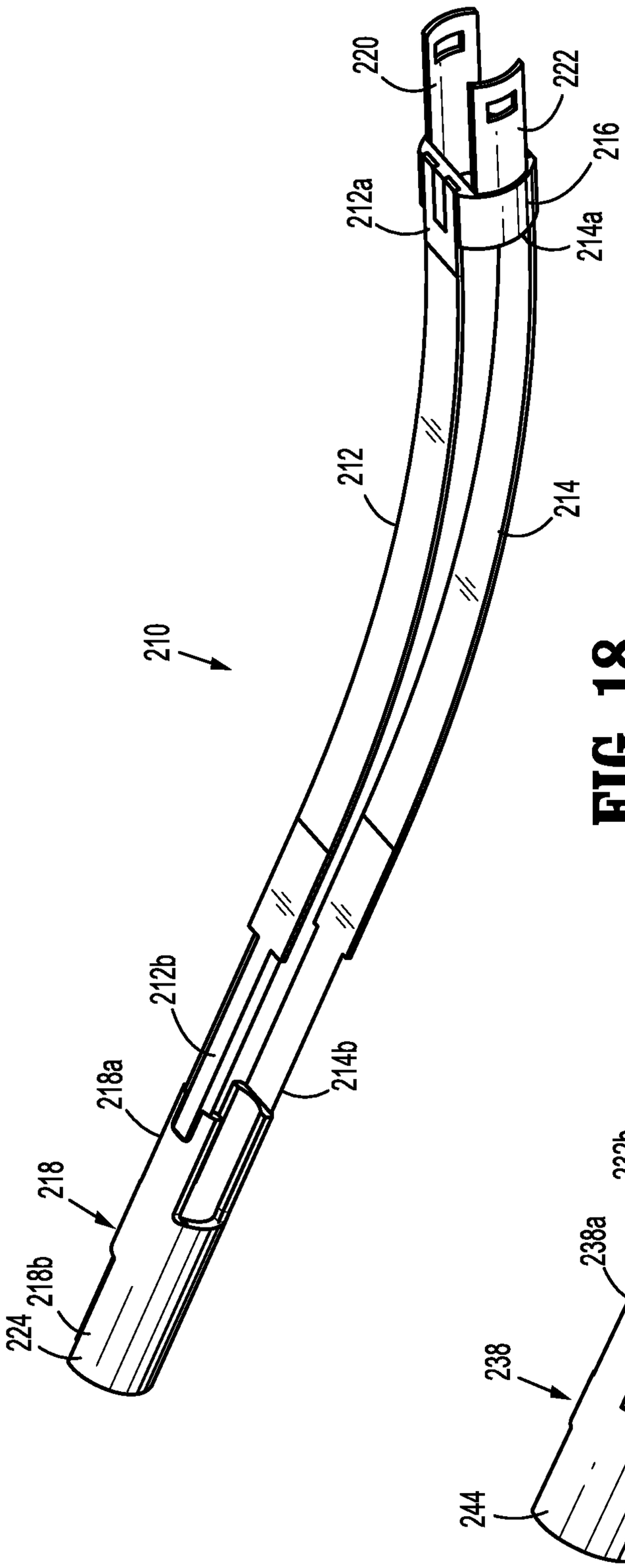
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FIG. 18

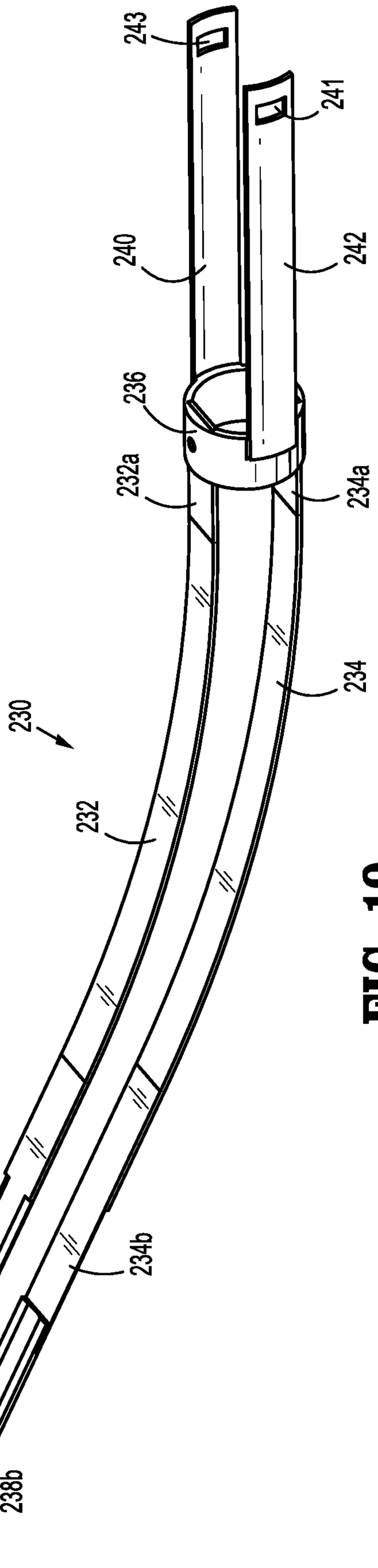
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FIG. 19

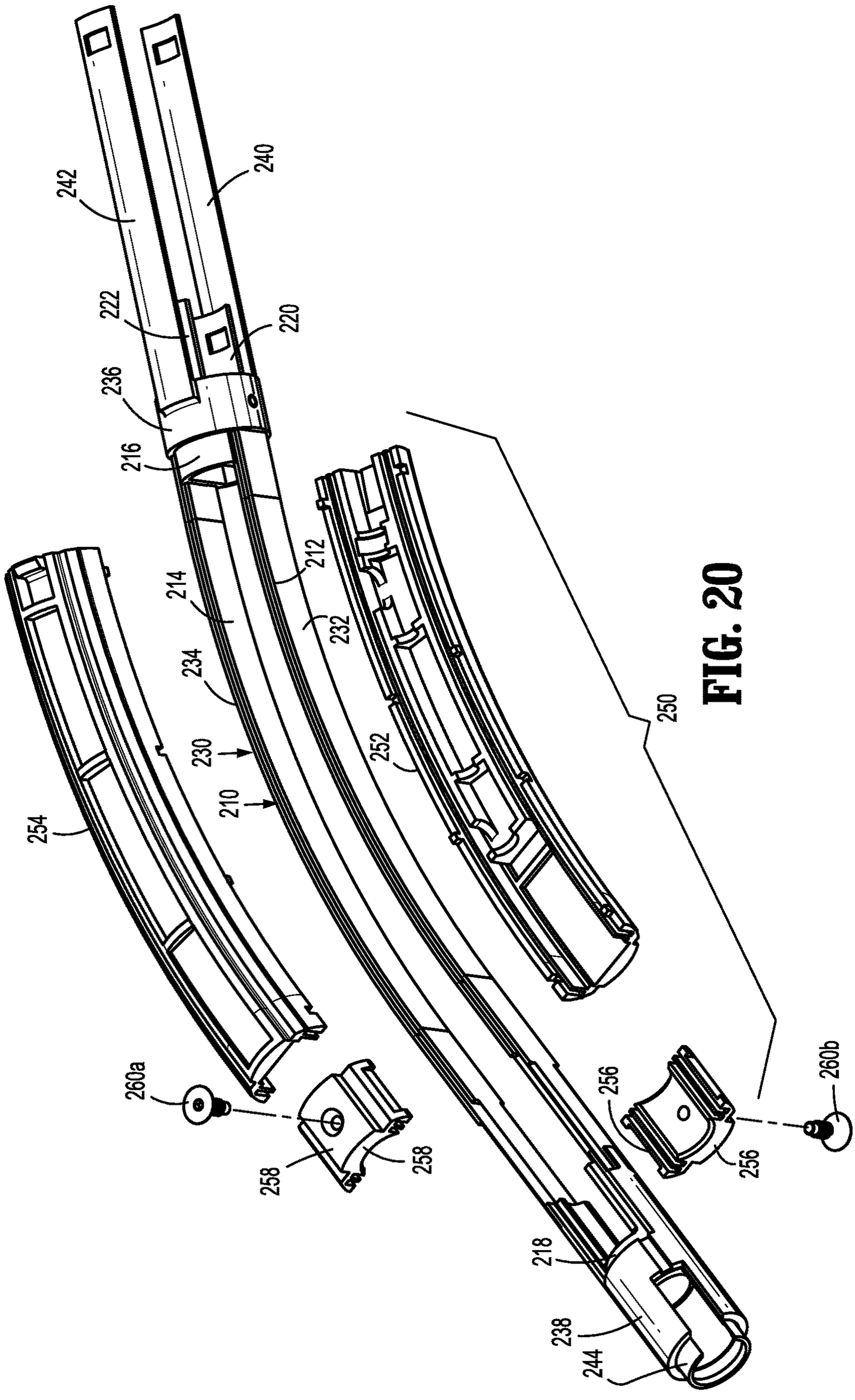
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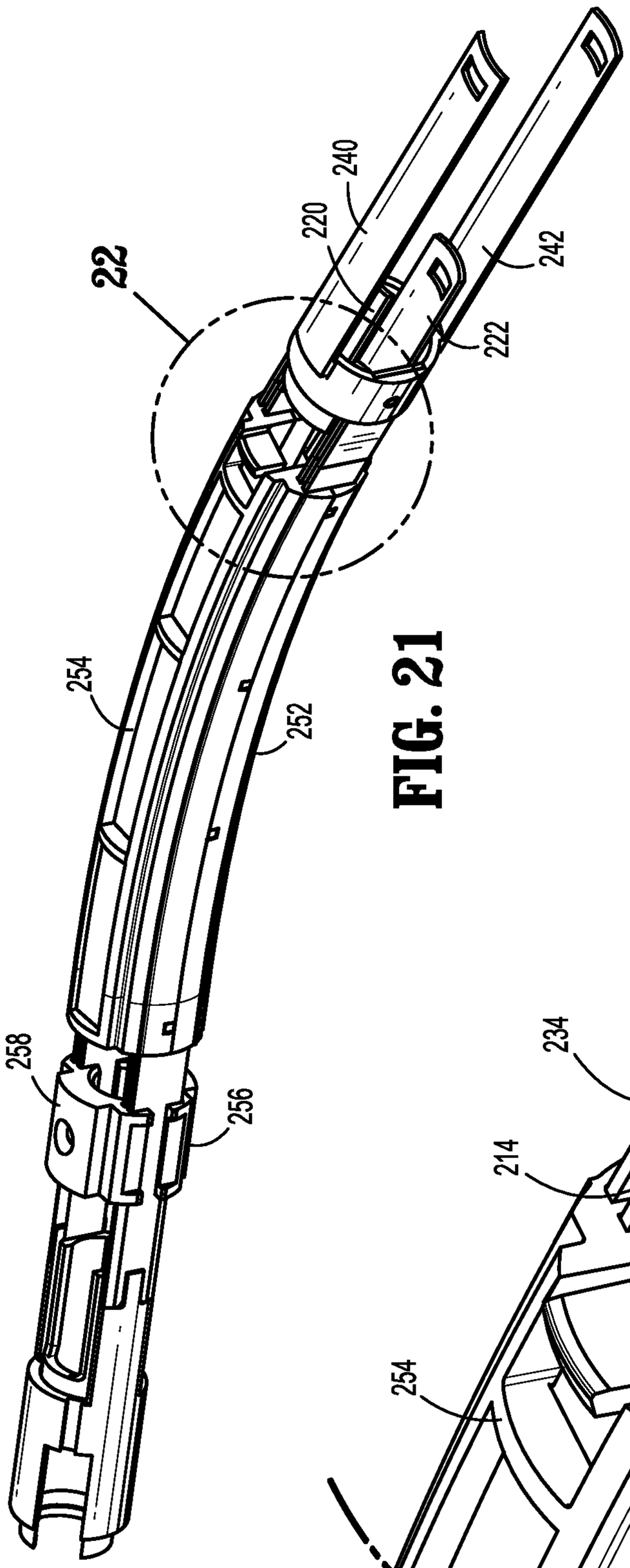
FIG. 20



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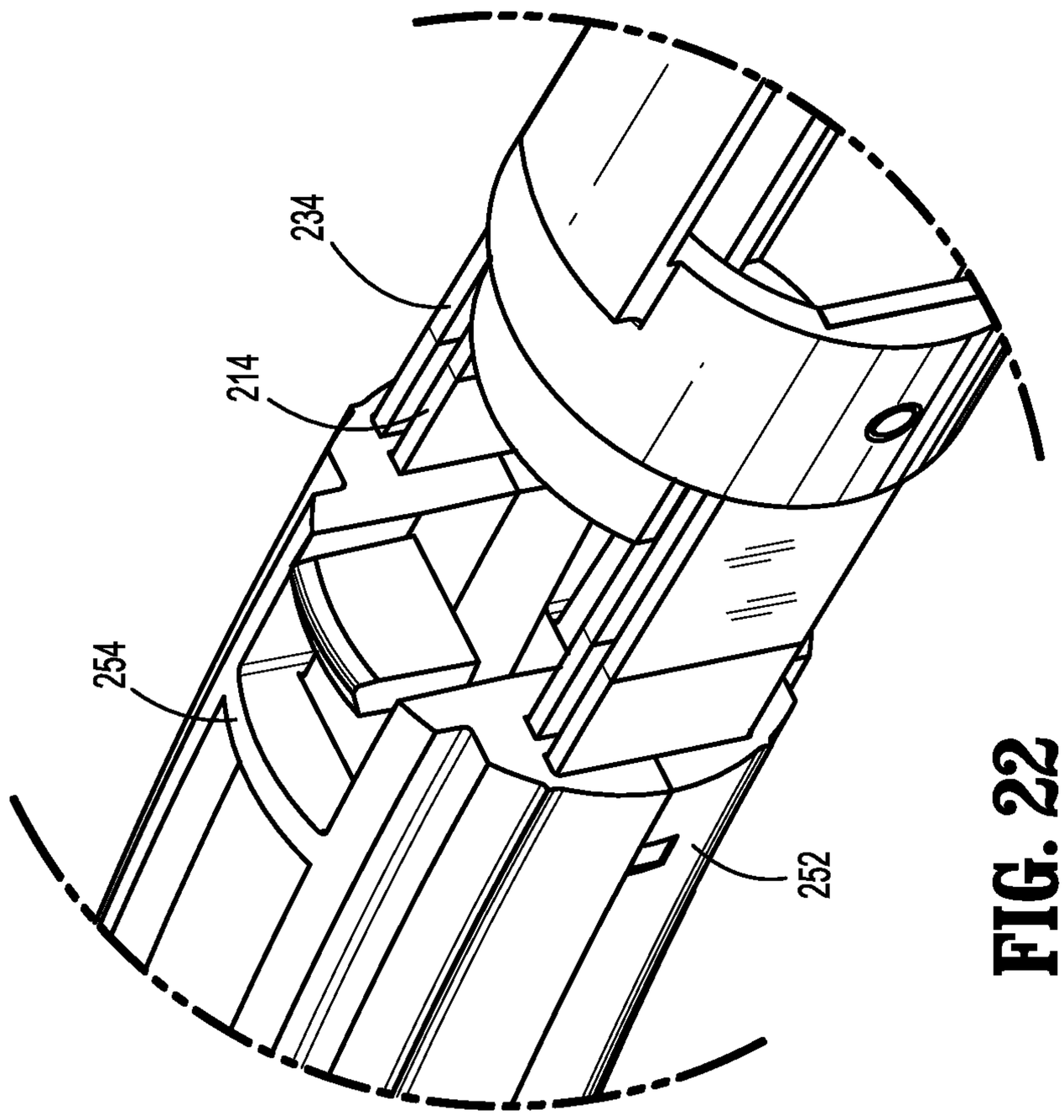

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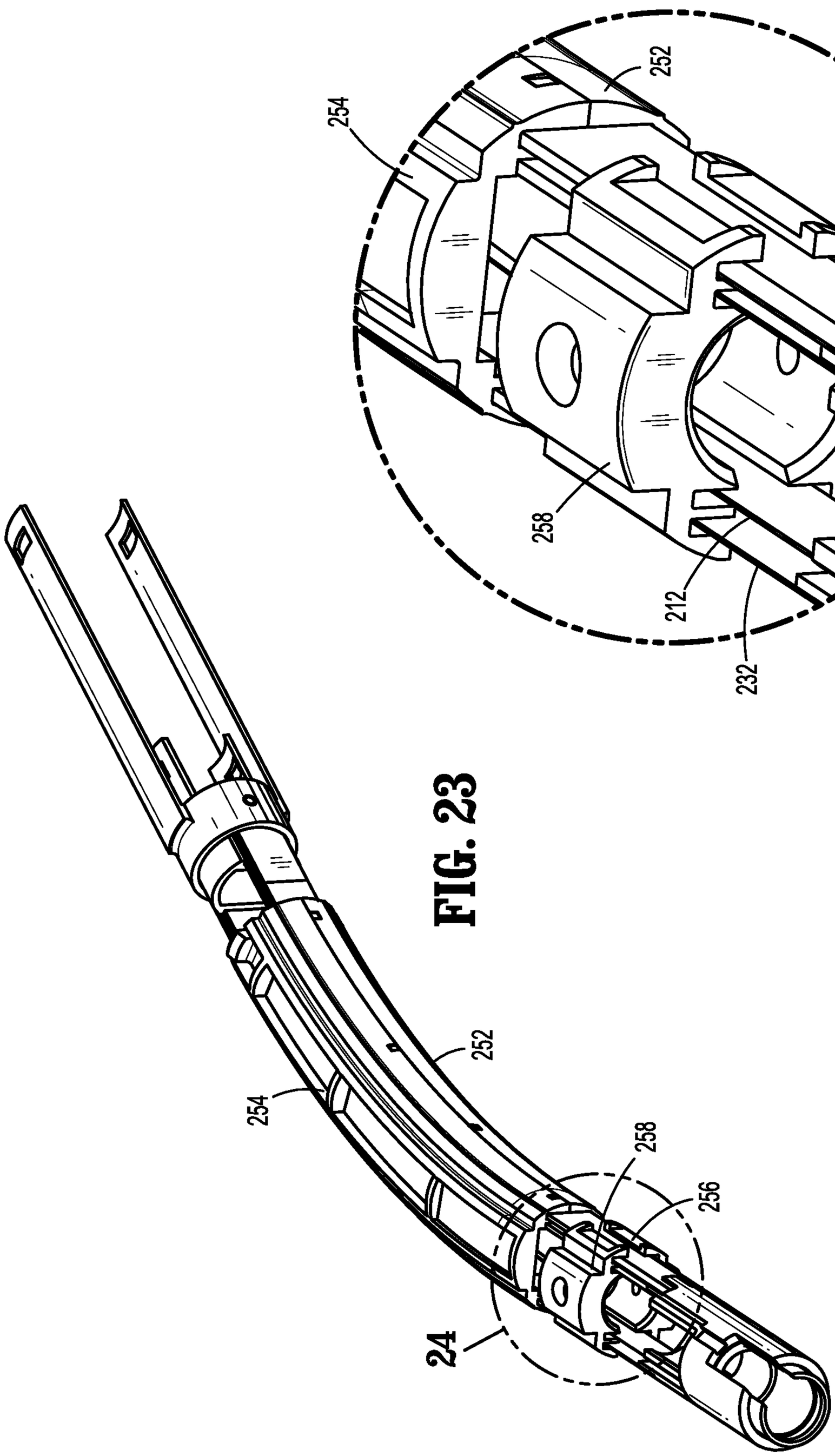
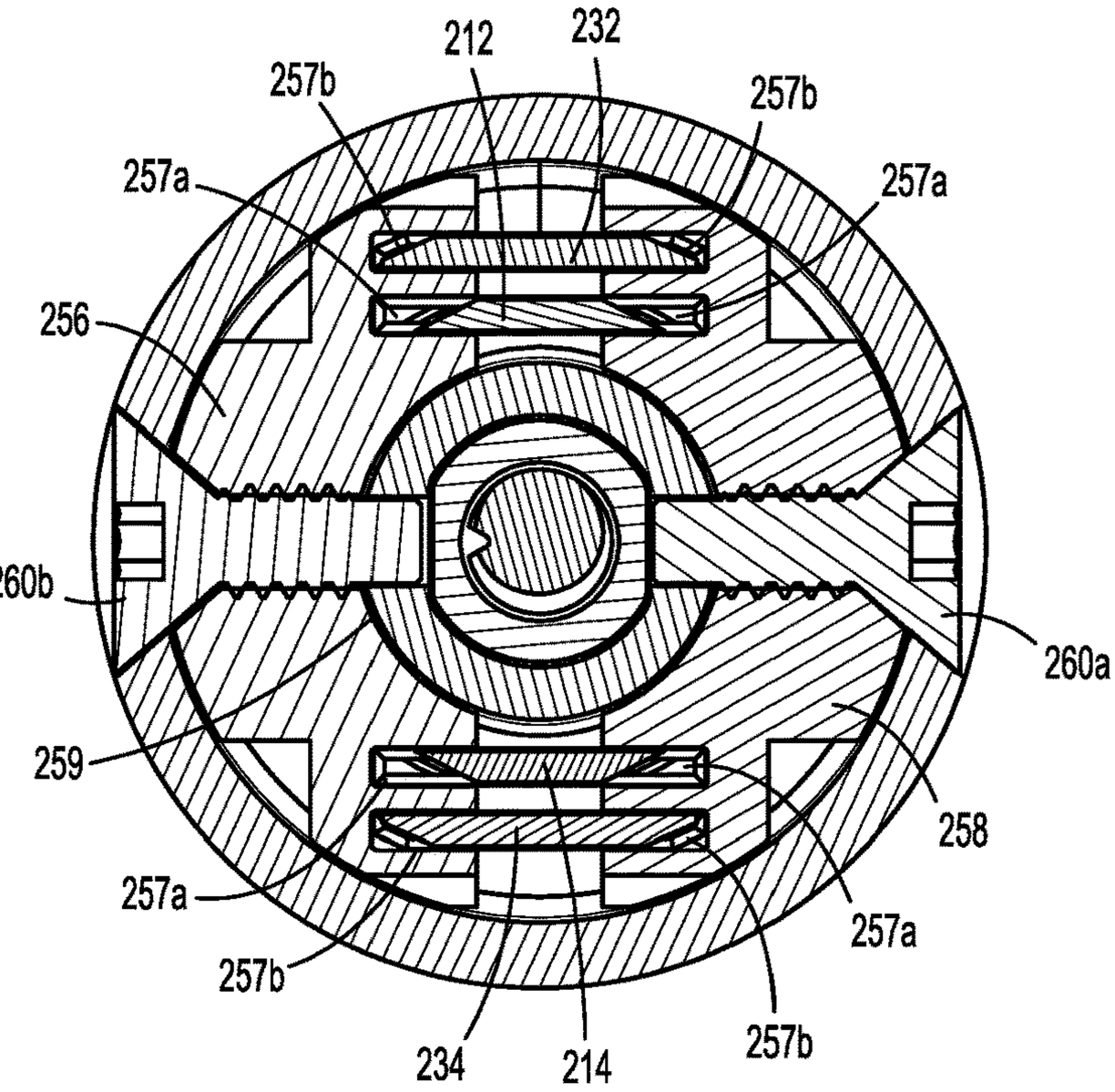


FIG. 23

FIG. 24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214

FIG. 25

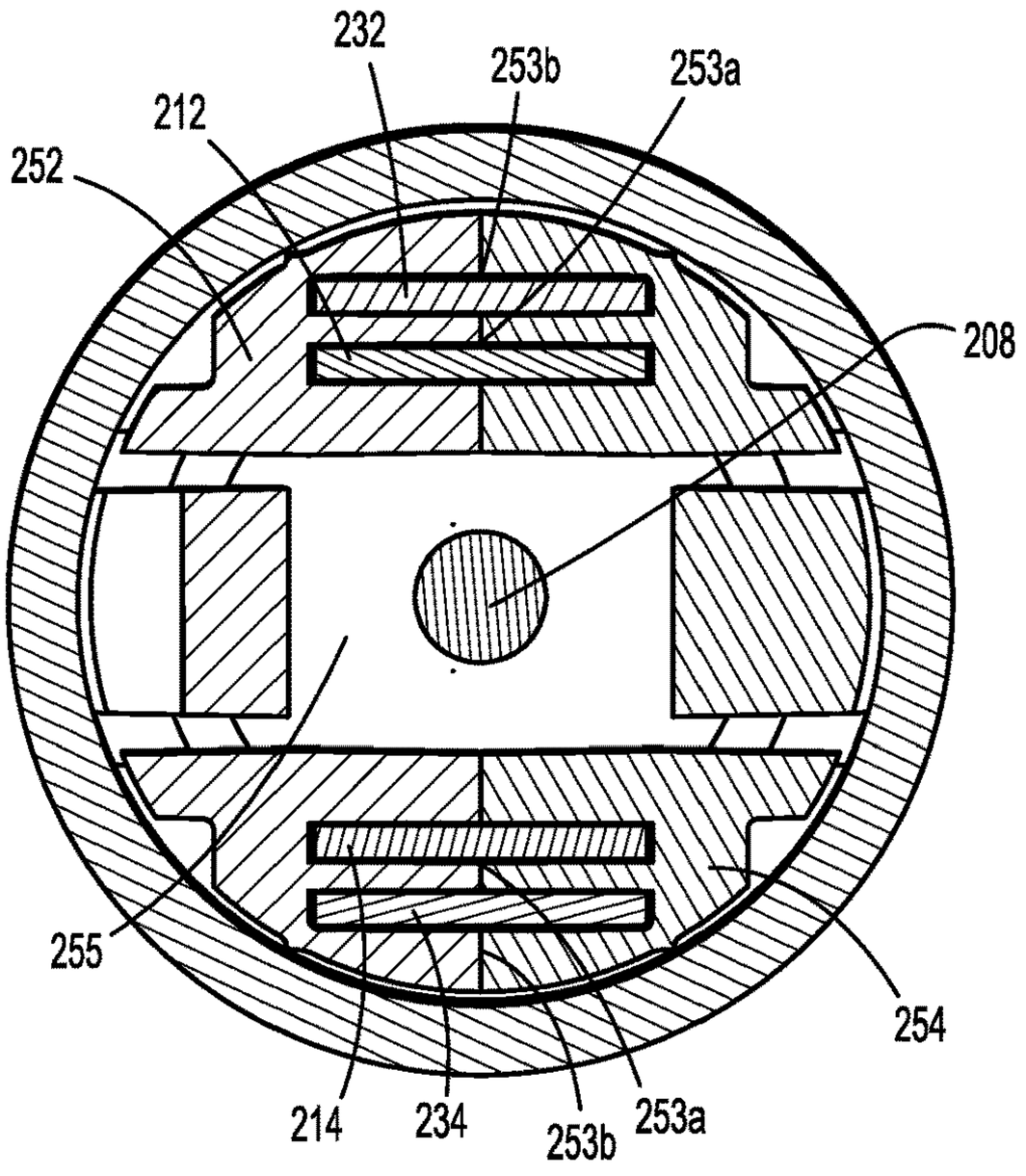
232
253b
253a
212
252
208
255
254
214
234
253b
253a

FIG. 26

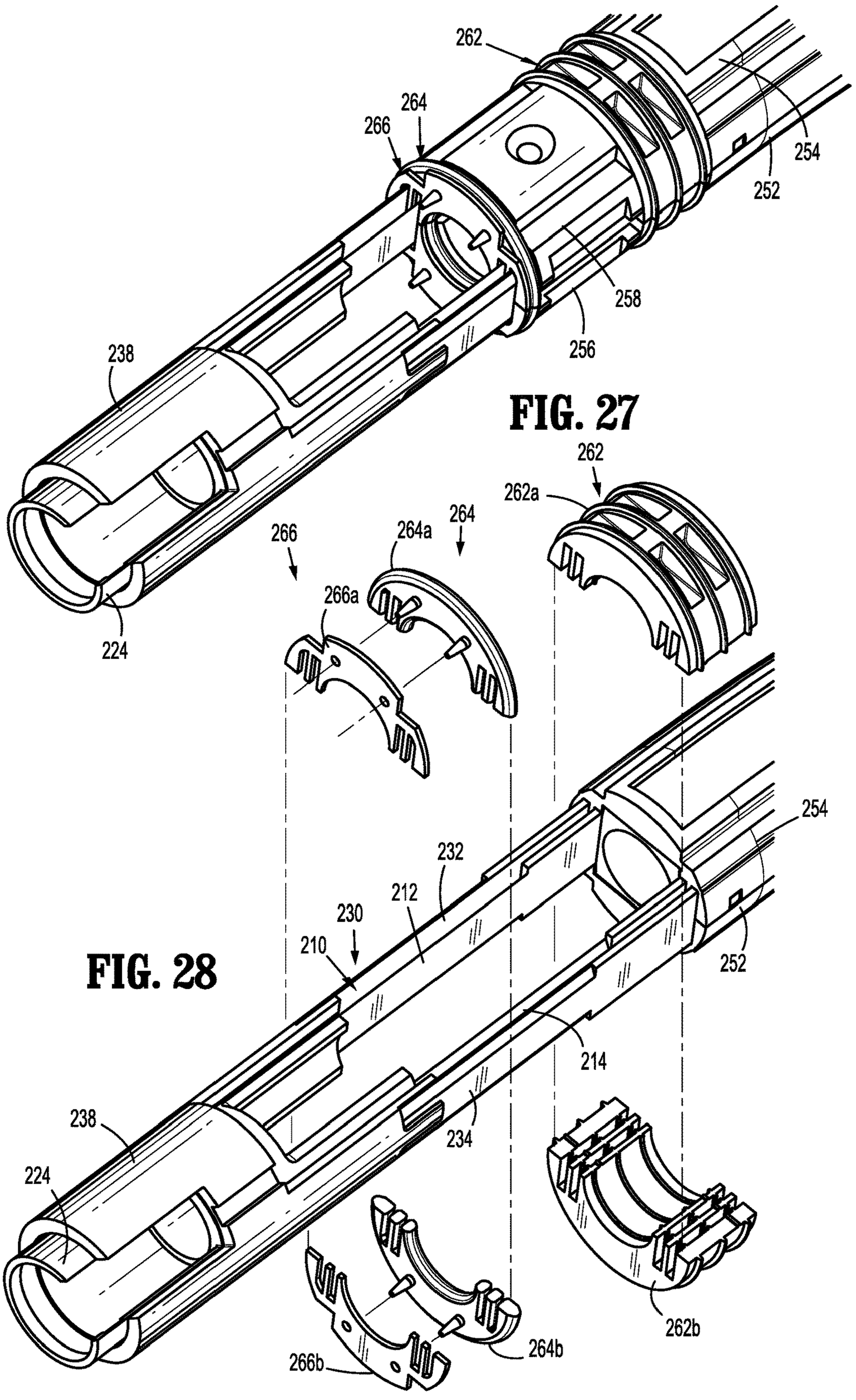
262
264
266
254
252
258
256
238
224
262
262a
264
264a
266
266a
254
232
212
230
210
252
214
234
238
224
262b
264b
266b

FIG. 27

FIG. 28

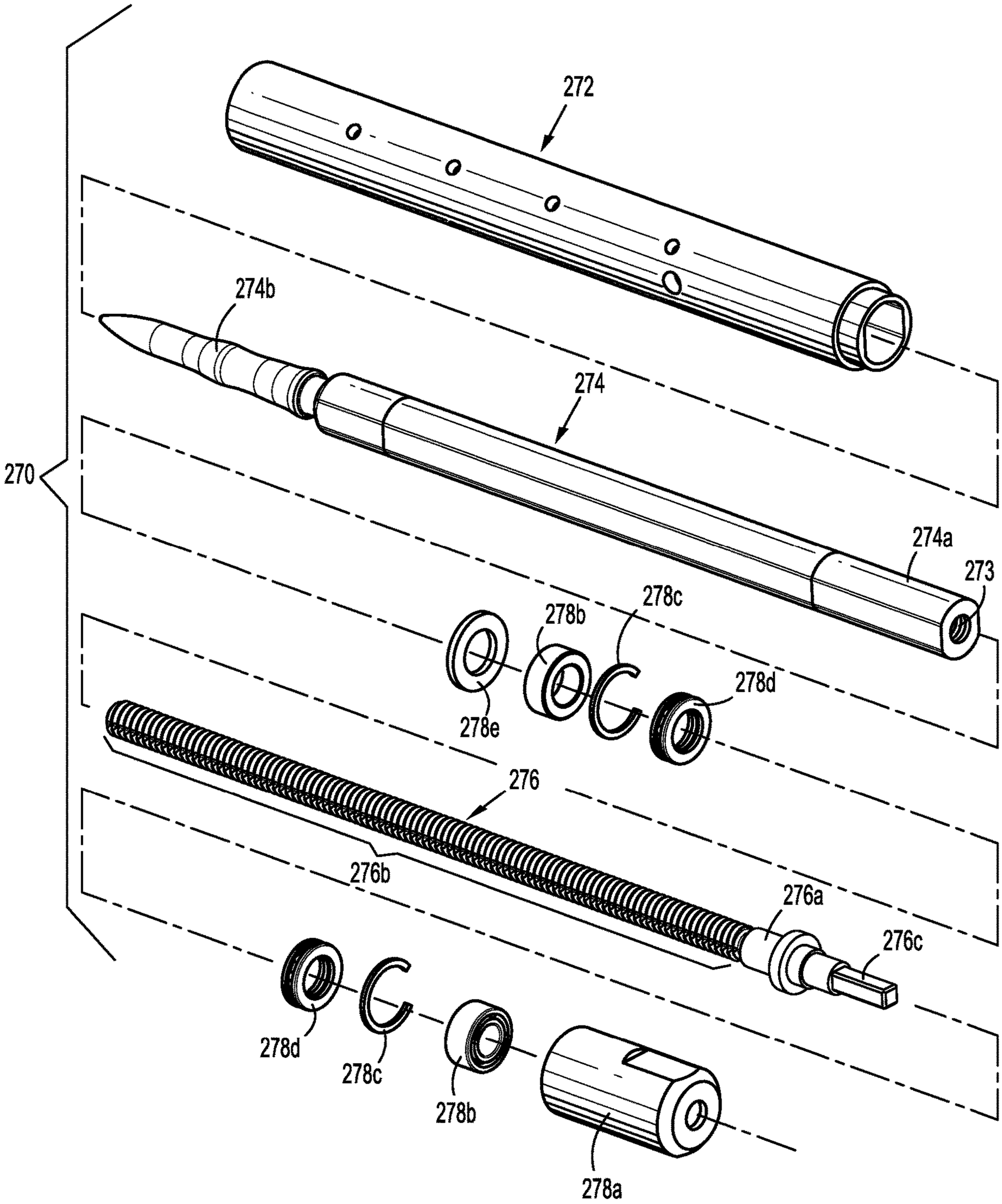
272
274b
274
270
274a
273
278c
278b
278d
278e
276
276b
276a
276c
278d
278c
278b
278a

FIG. 29

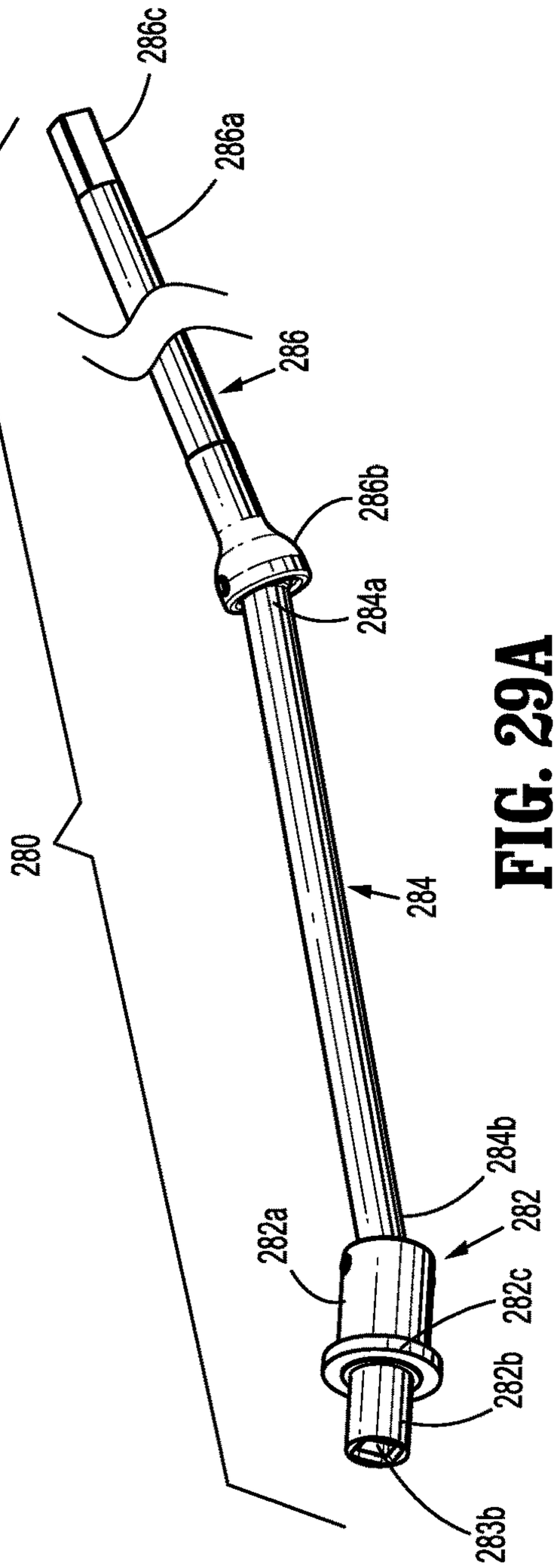

FIG. 29A

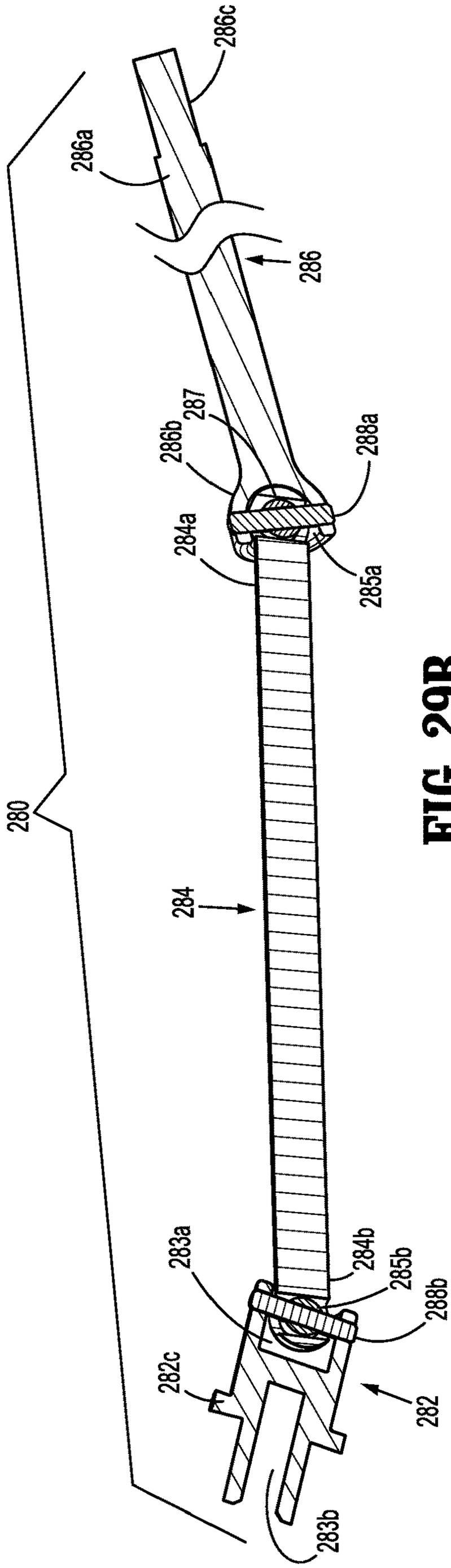

FIG. 29B

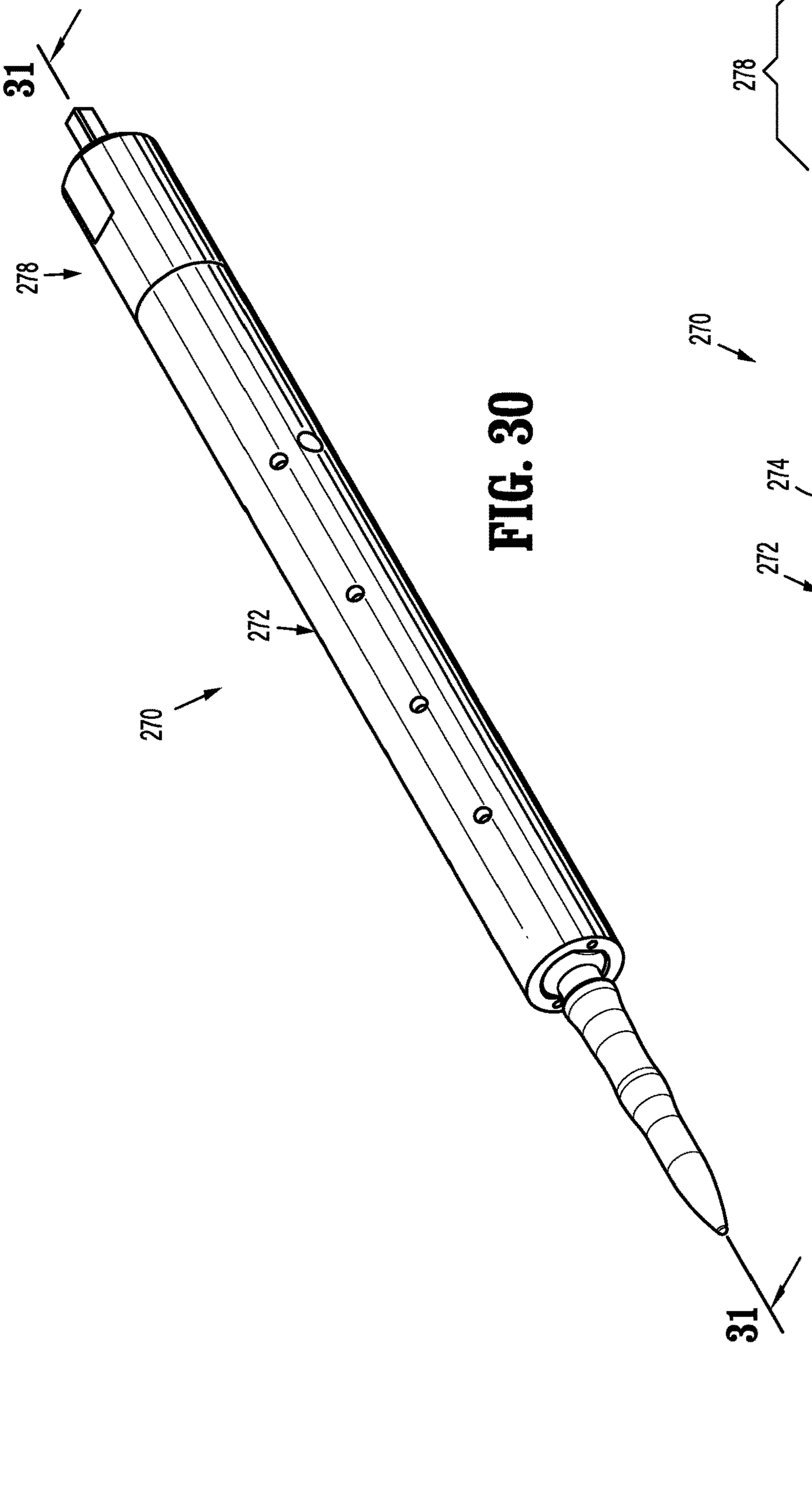

FIG. 30

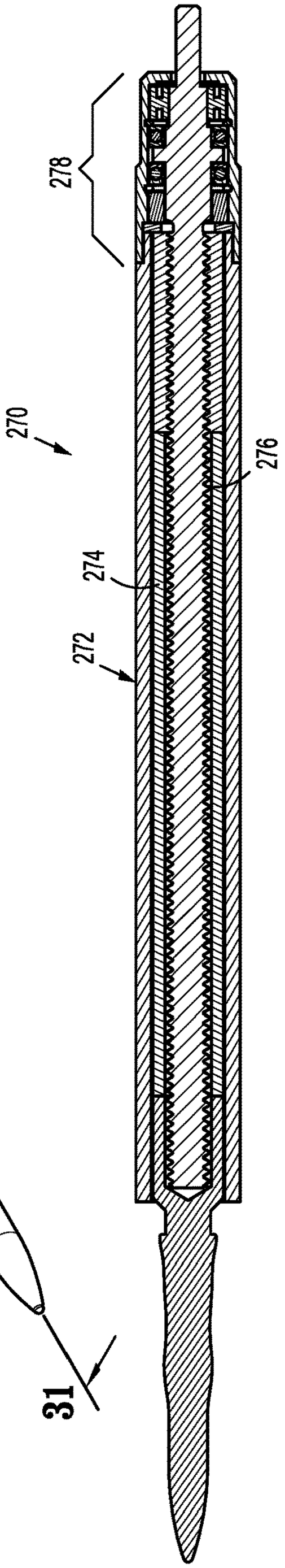

FIG. 31

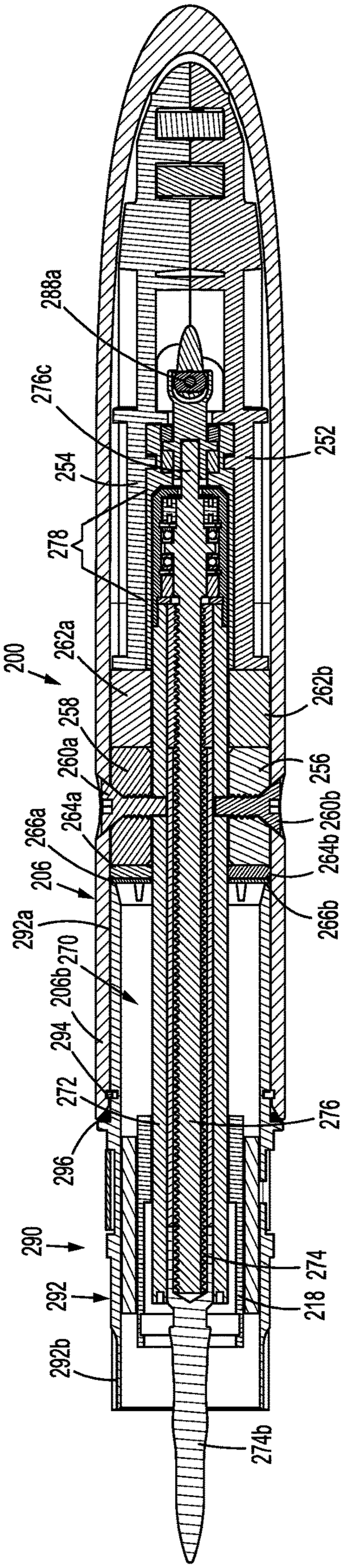
288a
276c
254
252
278
200
262a
262b
258
260a
256
264a
260b
266a
264b
206
266b
292a
270
206b
294
272
276
296
290
274
292
218
292b
274b

FIG. 32

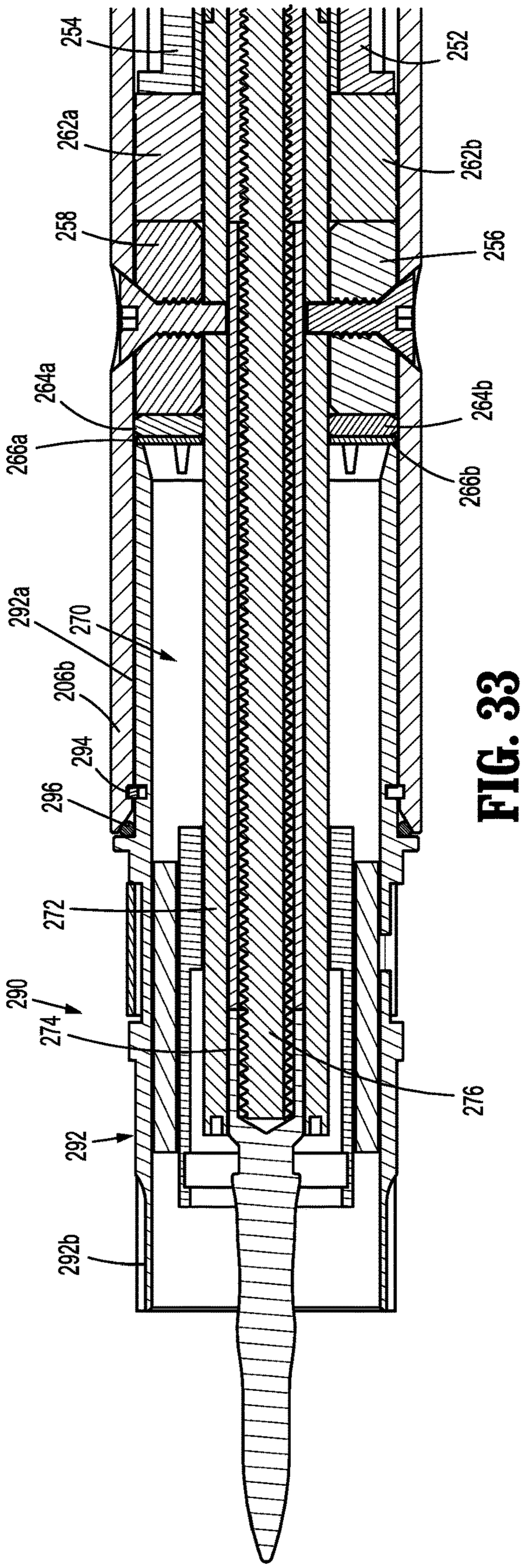
254
252
262a
262b
258
256
264a
264b
266a
266b
292a
270
206b
294
296
272
290
274
276
292
292b

FIG. 33

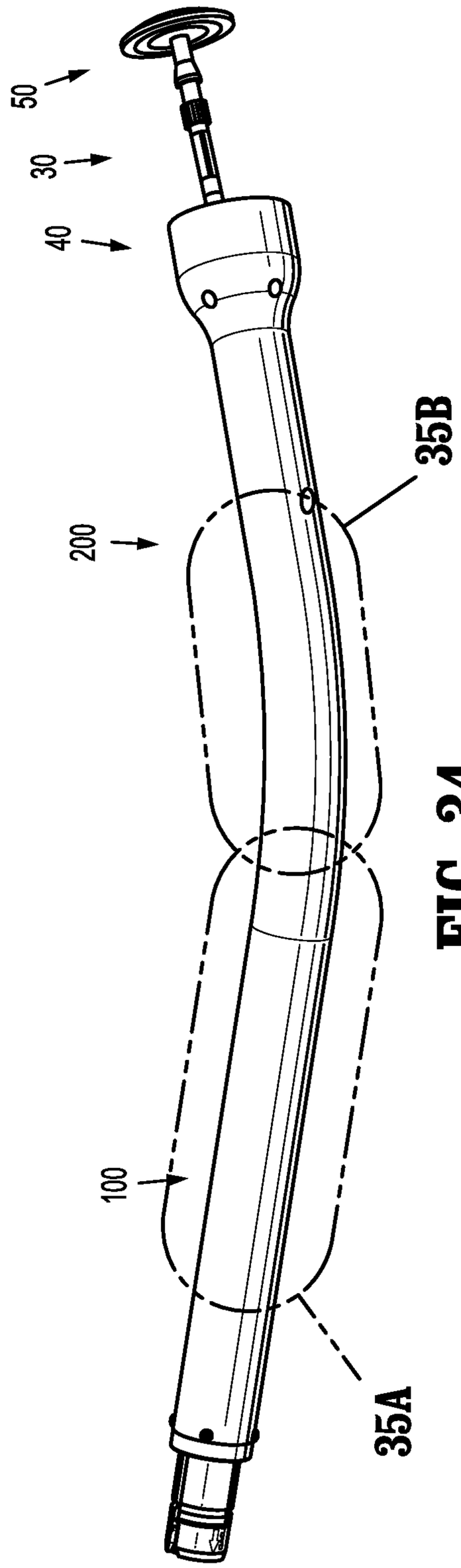

FIG. 34

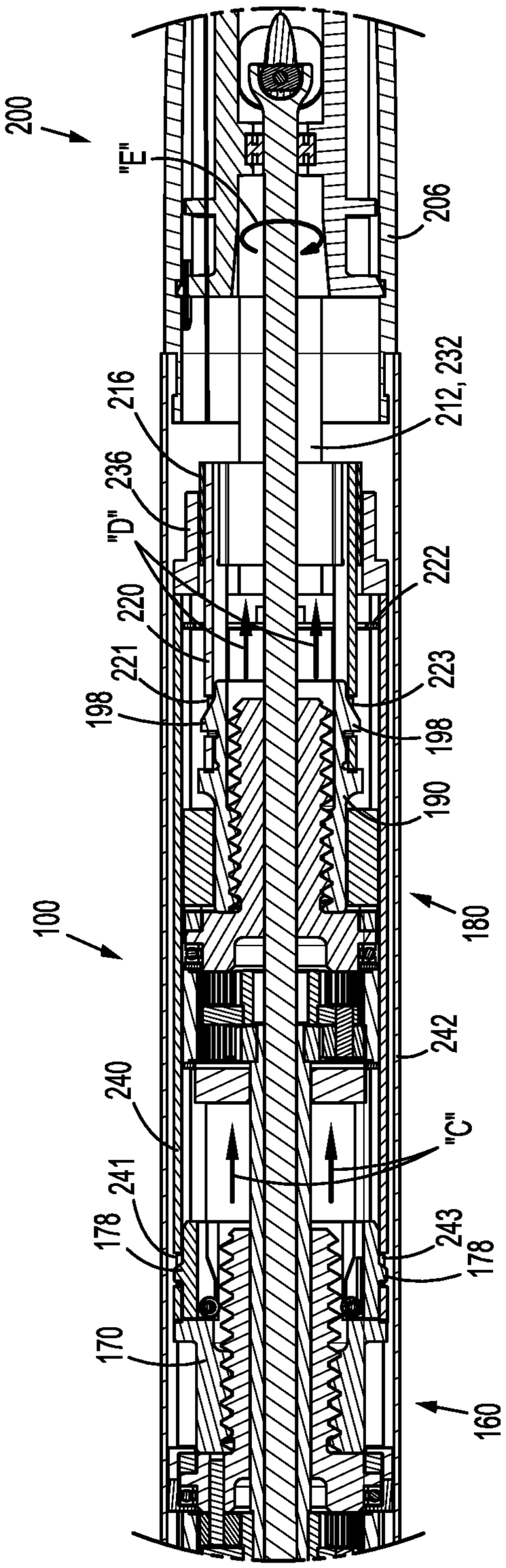

FIG. 35A

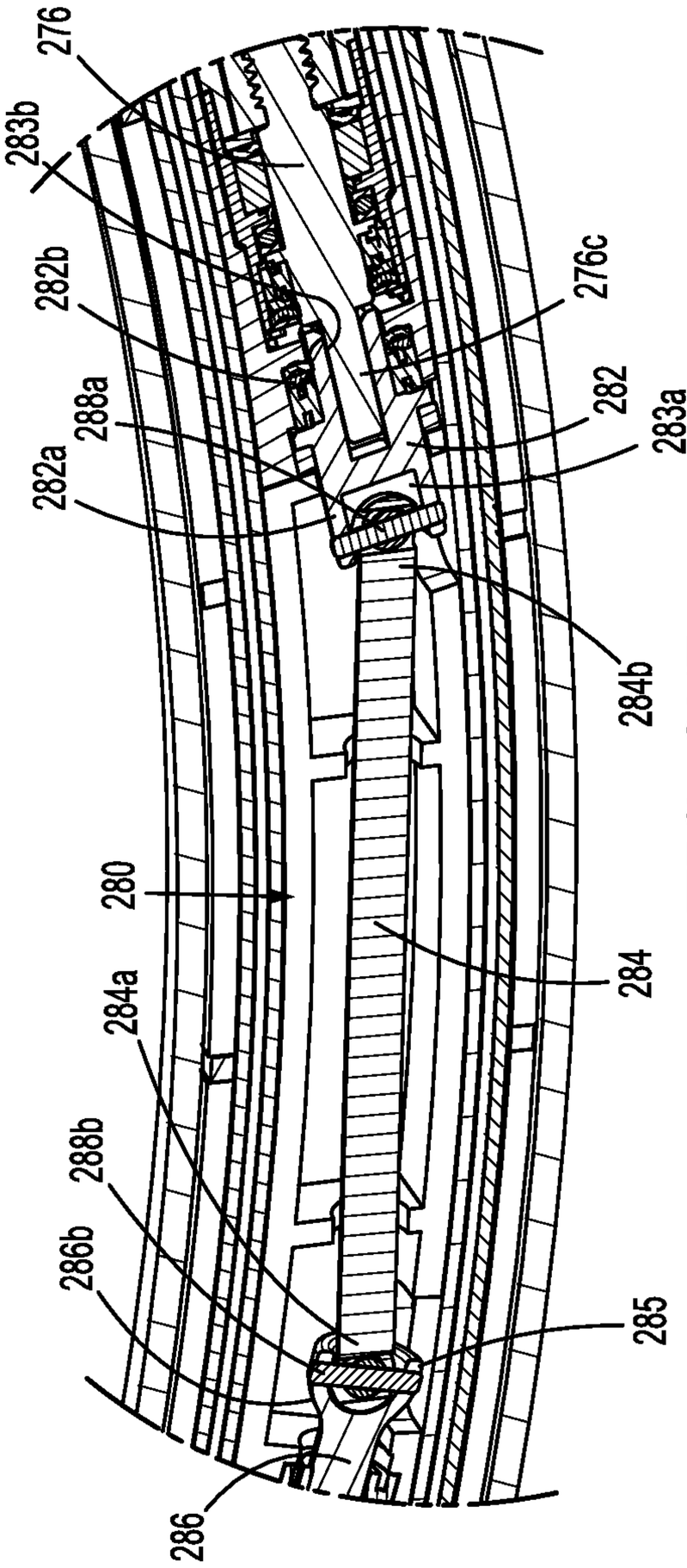

FIG. 35B

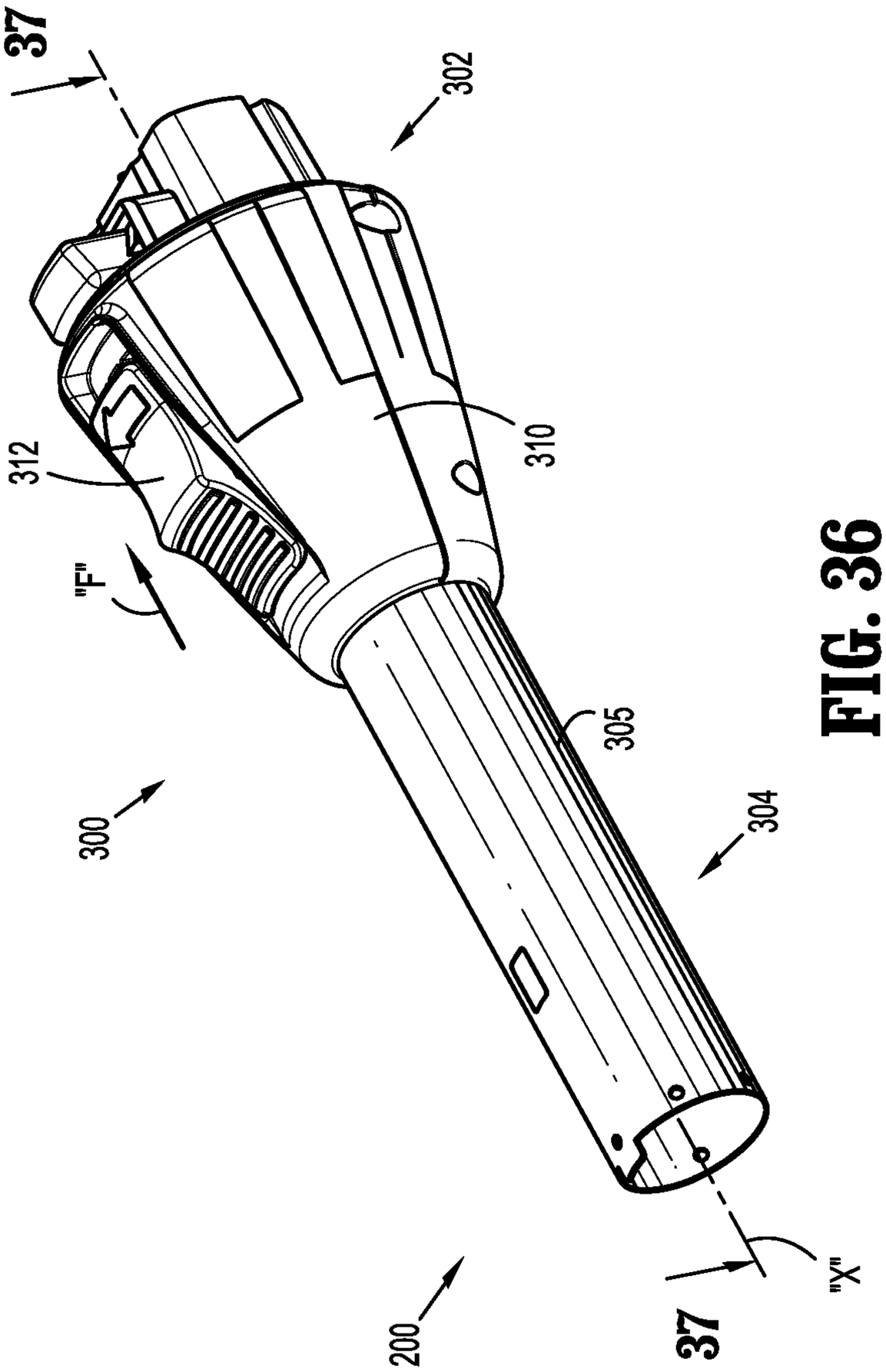

FIG. 36

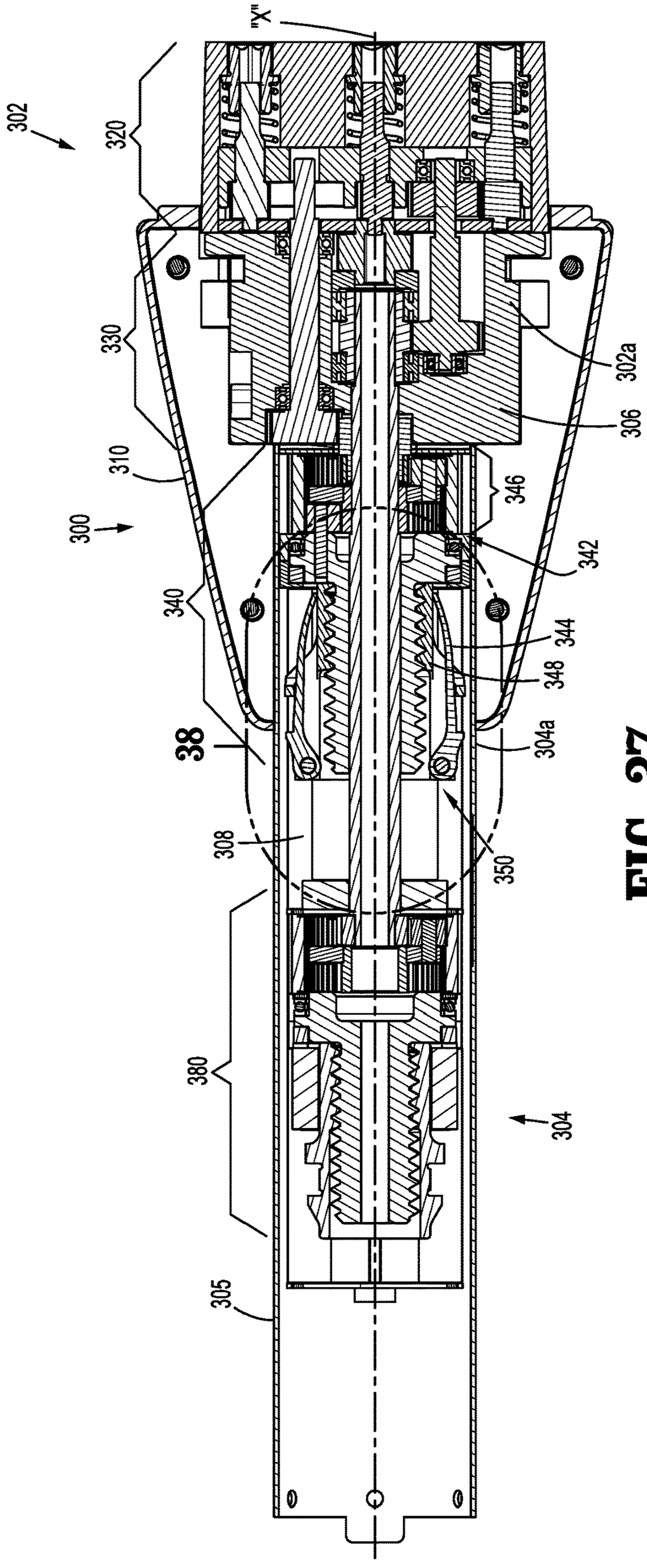
"X"
302
320
330
310
300
340
38
308
380
305
306
302a
346
342
344
348
304a
350
304

FIG. 37

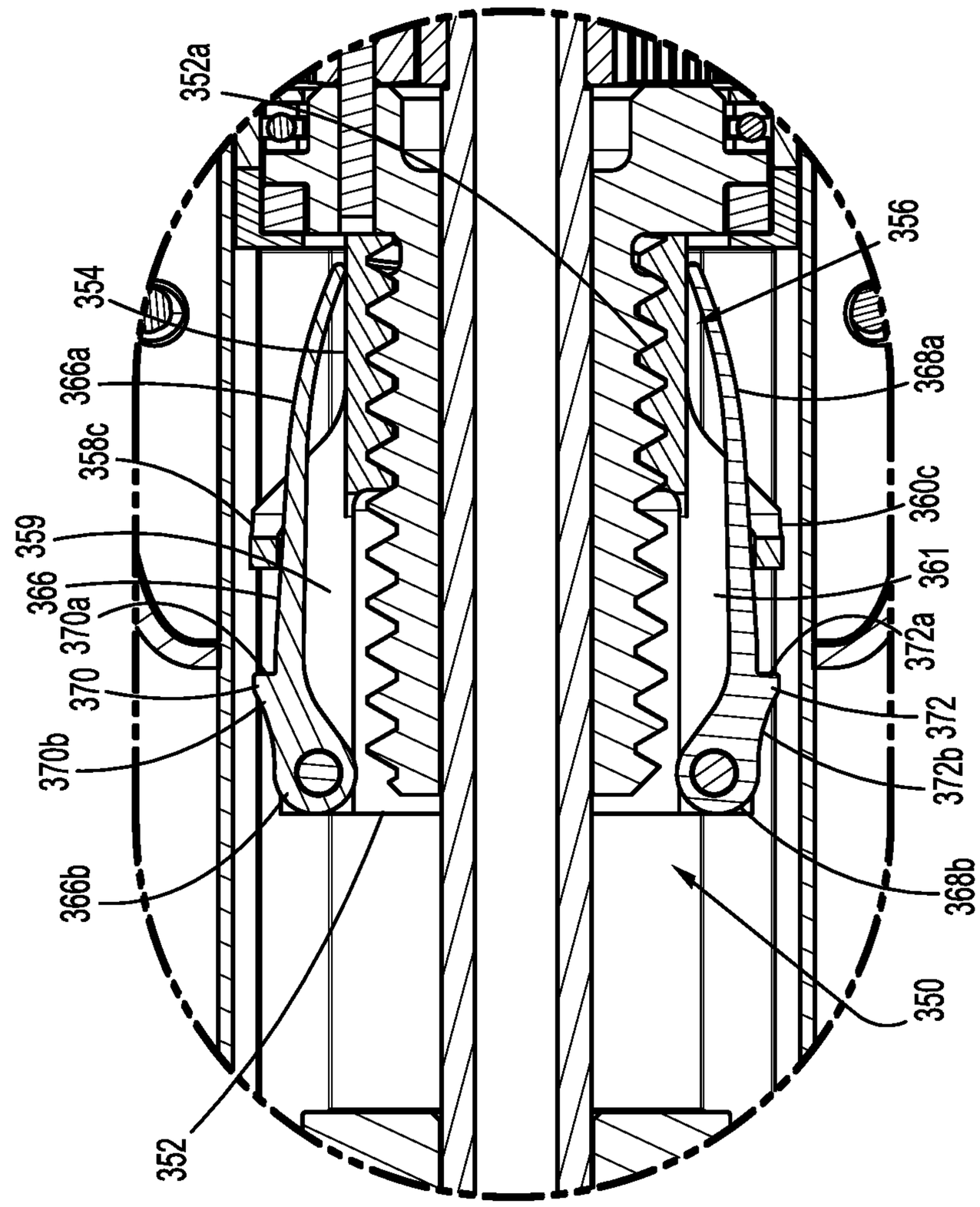
352a
354
366a
358c
359
366
370a
370
370b
366b
352
356
368a
360c
361
372a
372
372b
368b
350

FIG. 38

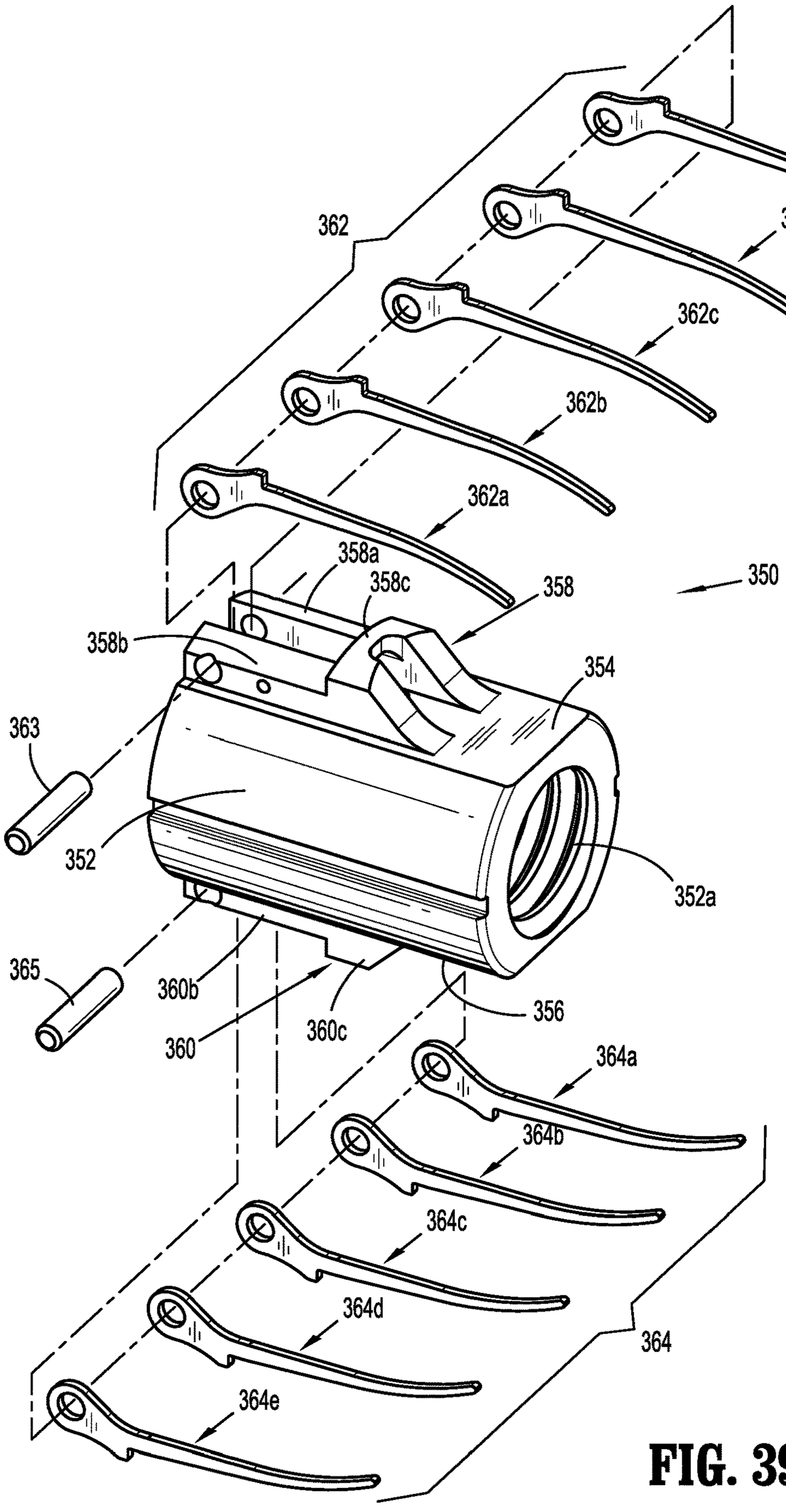
362e
362
362d
362c
362b
362a
358a
358c
358
350
358b
354
363
352
352a
365
360b
360
360c
356
364a
364b
364c
364d
364
364e

FIG. 39

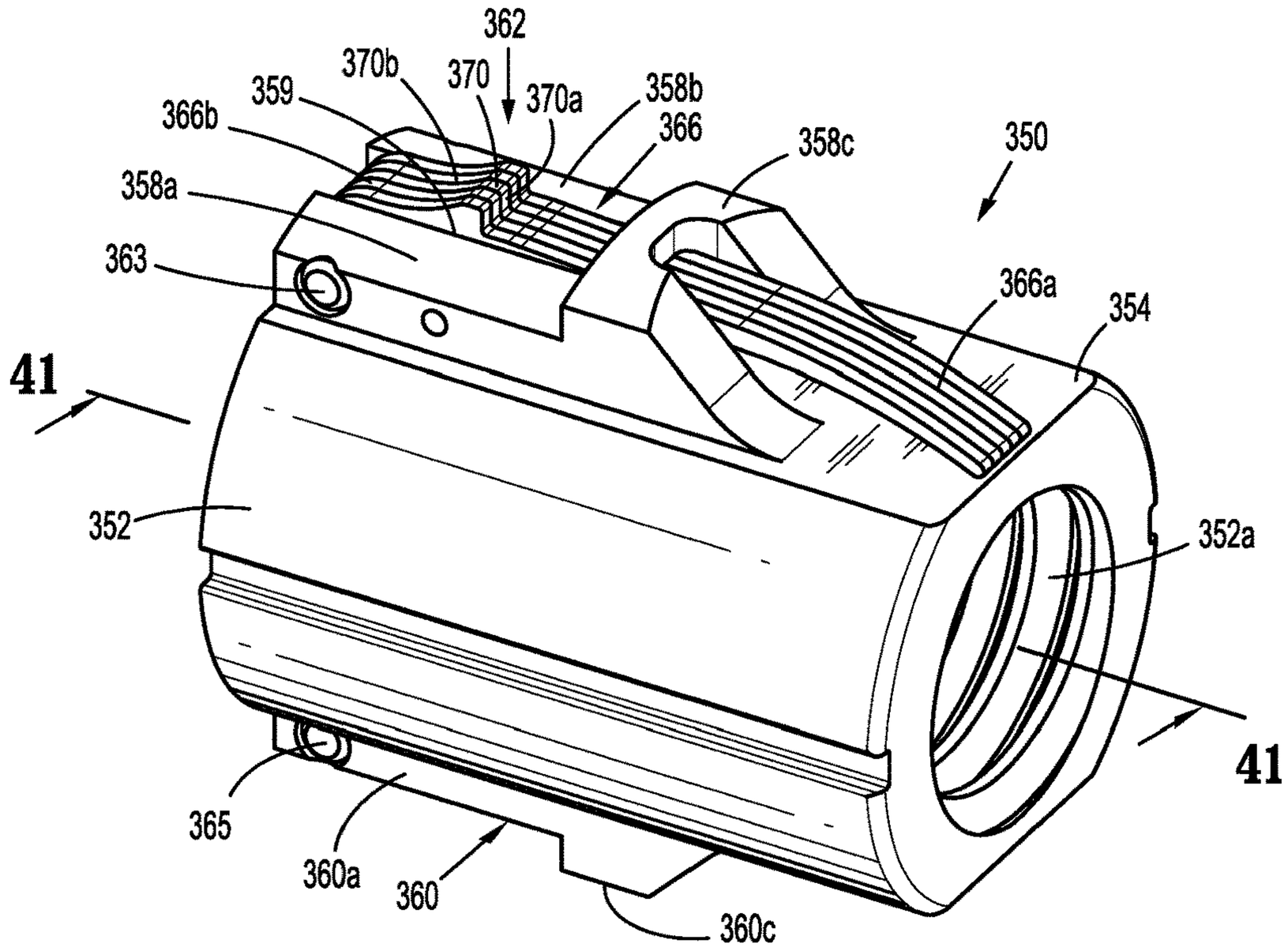
362
370b
370
370a
359
366b
358b
366
358a
358c
350
363
366a
354
41
352
352a
41
365
360a
360
360c

FIG. 40

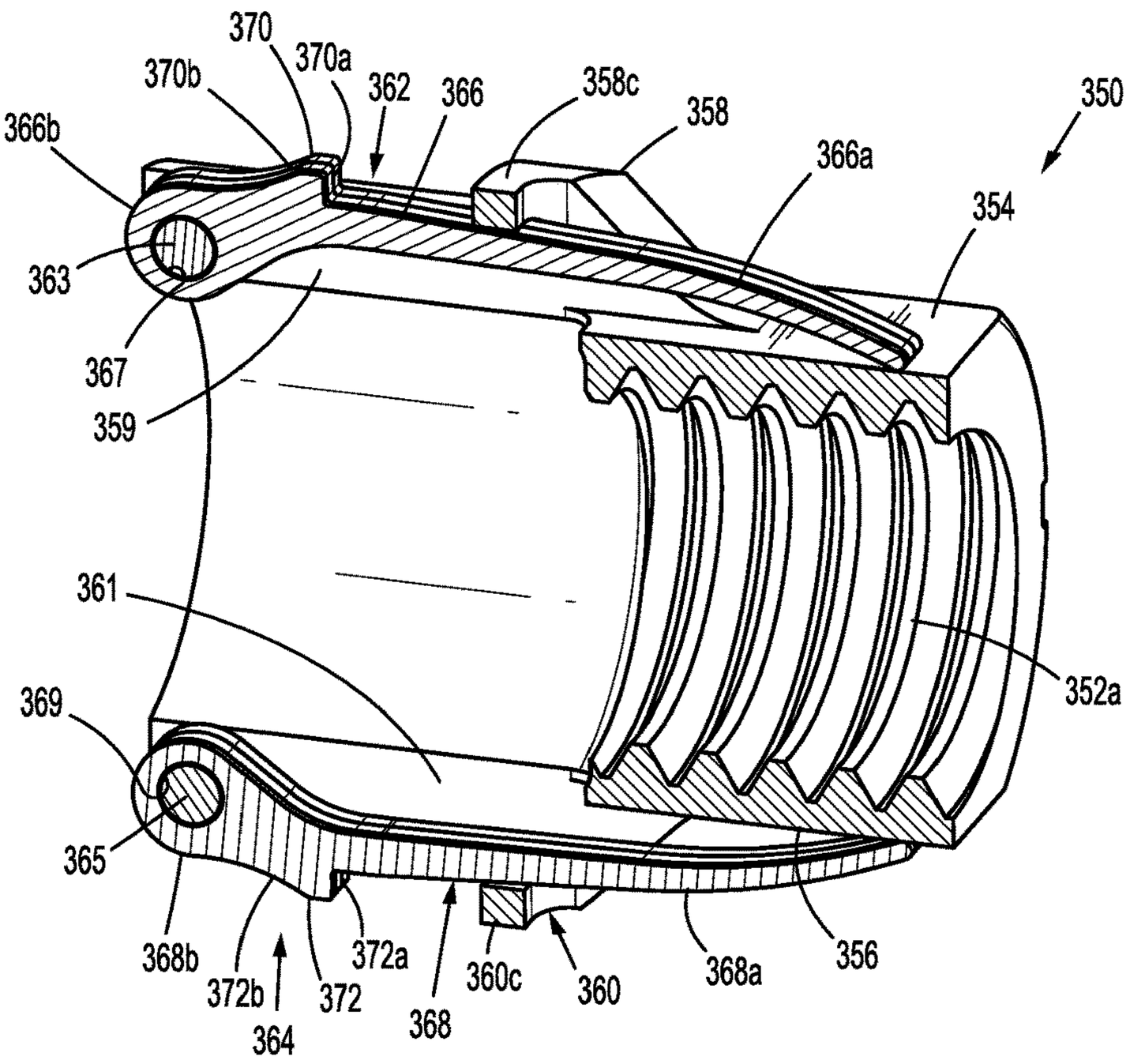
370
370a
370b
362
366
358c
358
350
366b
366a
354
363
367
359
361
369
352a
365
368b
372b
364
372
372a
368
360c
360
368a
356

FIG. 41

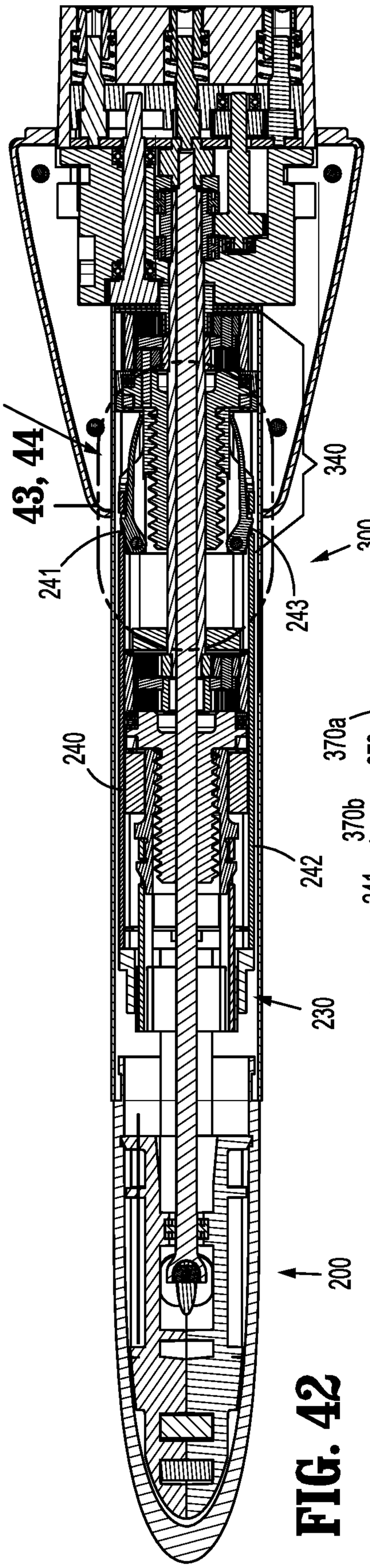
350
43, 44
241
340
300
243
240
242
230
200

FIG. 42

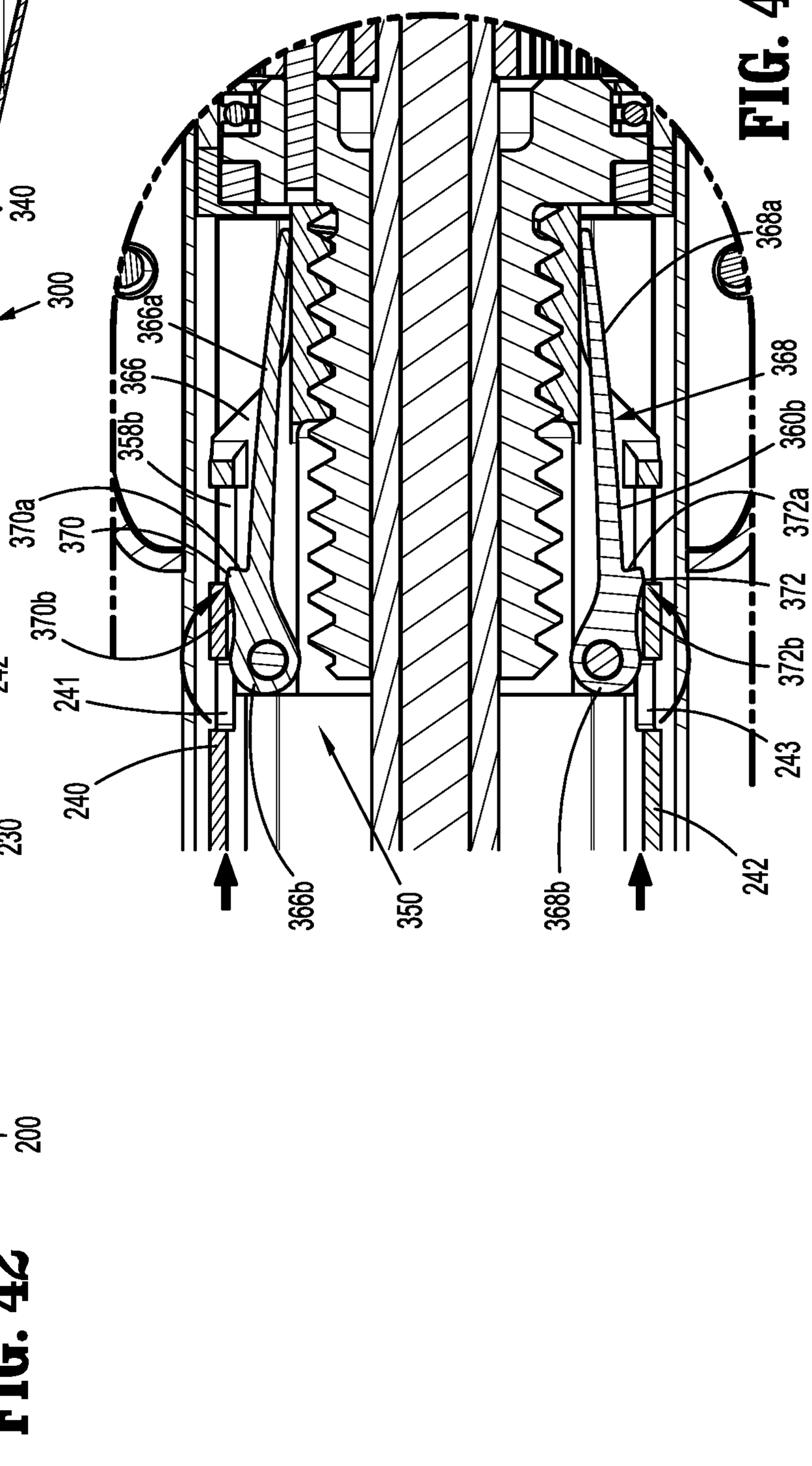
368a
366a
366
368
358b
360b
370a
372a
370
372
370b
372b
241
243
240
242
366b
350
368b

FIG. 43

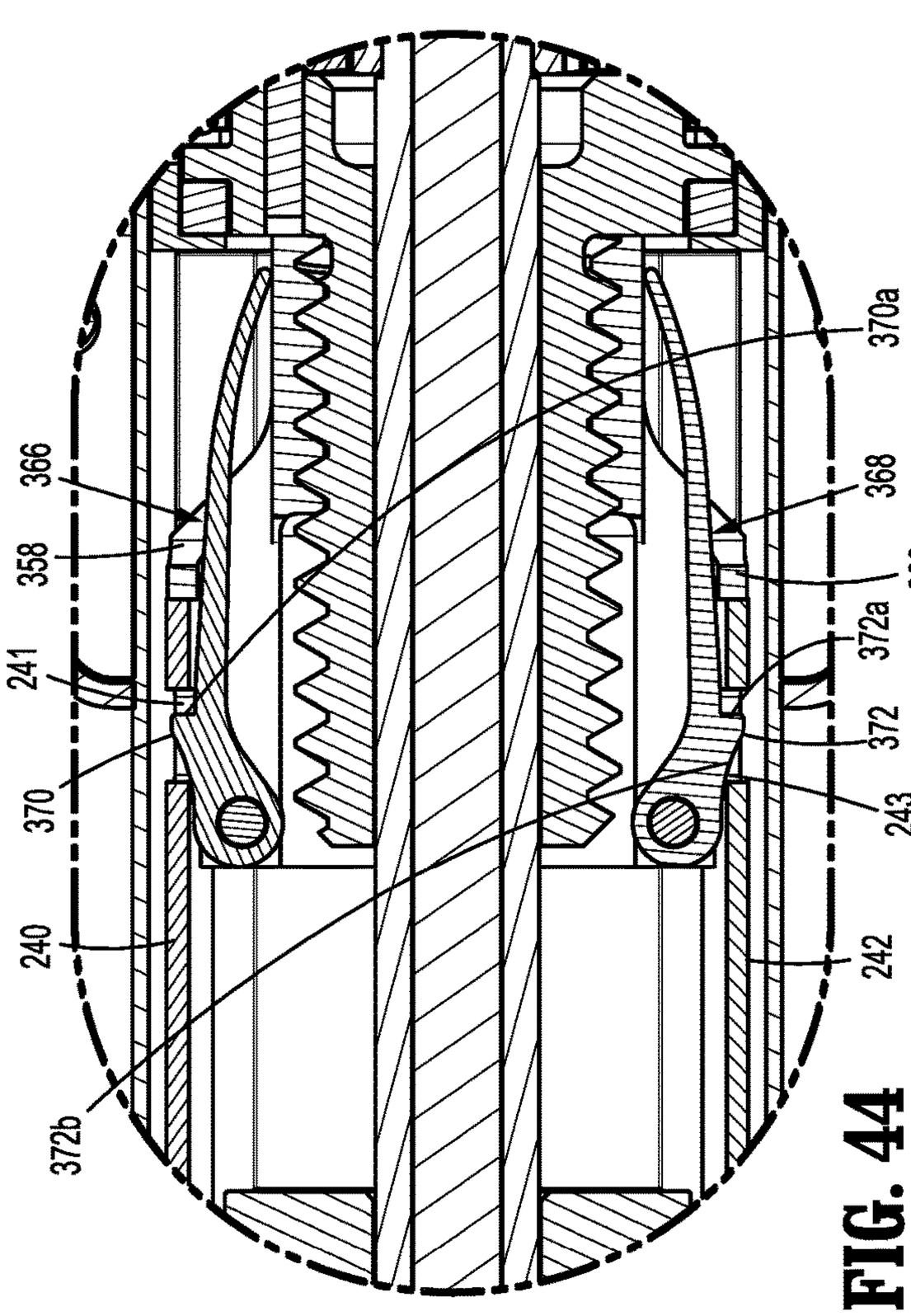
366
358
241
370
240
372b
370a
368
360
372a
372
243
242

FIG. 44

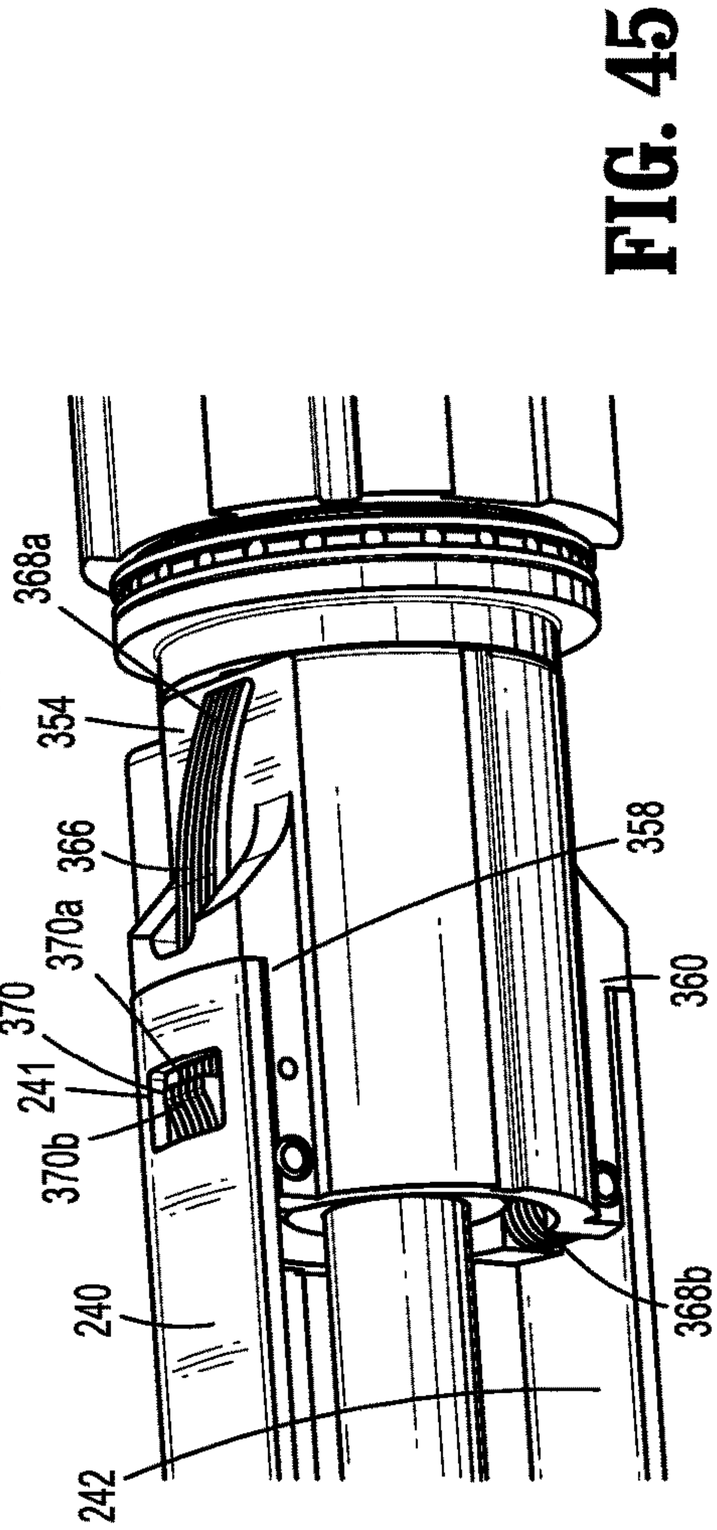
368a
354
366
370a
370
241
370b
240
242
358
360
368b

FIG. 45

ADAPTER, EXTENSION, AND CONNECTOR ASSEMBLIES FOR SURGICAL DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of and priority to U.S. Provisional Patent Application No. 62/251,930, filed Nov. 6, 2015, the entire disclosure of which is incorporated by reference herein.

BACKGROUND

1. Technical Field

The present disclosure relates generally to powered surgical devices. More specifically, the present disclosure relates to an adapter assembly for selectively connecting an extension assembly including an end effector to the actuation units of the powered surgical devices.

2. Background of Related Art

Powered devices for use in surgical procedures are known. To permit reuse of the handle assemblies of these powered surgical devices and so that the handle assembly may be used with a variety of end effectors, adapter assemblies and extension assemblies have been developed for selective attachment to the handle assemblies and to a variety of end effectors. Following use, the adapter and/or extension assemblies may be disposed of along with the end effector. In some instances, the adapter assemblies and extension assemblies may be sterilized for reuse.

SUMMARY

A surgical assembly for operably connecting an end effector to an electrosurgical instrument is provided. The surgical assembly includes an adapter assembly including a connector assembly, a drive transfer assembly operably received through the connector assembly and including a first rotatable shaft, and a first pusher assembly operably connected to the first rotatable shaft for converting rotational motion from the first rotatable shaft to longitudinal movement to perform a first function, the first pusher assembly including a first pusher member and first and second pawl assemblies. The surgical assembly further includes an extension assembly operably connected to a distal end of the adapter assembly. The extension assembly includes a flexible band assembly operably connectable to the first and second pawl assemblies of the first pusher assembly.

In embodiments, the surgical assembly further includes a second pusher assembly, and a second rotatable shaft operably connected to the second pusher assembly for converting rotational motion from the second rotatable shaft to longitudinal movement to perform a second function. The surgical assembly may further include a drive member, and a third rotatable shaft operably connected to the drive assembly for transferring rotational motion from the third rotatable shaft to perform a third function. The first pawl assembly may include a first plurality of pawl members, and the second pawl assembly includes a second plurality of pawl members. The flexible band assembly may include first and second connector members. Each of the first and second connector members may define an opening configured for selective receipt of a respective one of the first and second pawl assemblies.

In some embodiments, the first plurality of pawl members includes a protrusion selectively receivable within the opening of the first connector member, and the second plurality of pawl members includes a protrusion selectively receivable within the opening of the second connector member. Each of the protrusions may include a flat proximal facing surface and a slanted distal facing surface. The first and second plurality of pawl members may be pivotally secured to the pusher member.

The pusher member may include a first retainer for supporting the first plurality of pawl members, and a second retainer for supporting the second plurality of pawl members. The first and second retainers may each define a longitudinal slot for receiving the respective first and second plurality of pawl members. The first plurality of pawl members may be pivotally received within the longitudinal slot of the first retainer, and the second plurality of pawl members may be pivotally received within the longitudinal slot of the second retainer. Each of the first and second plurality of pawl members may be configured to flex radially inward. The first and second plurality of pawl members may each include a curved profile. The first and second plurality of pawl members may each be formed of a resilient material.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present disclosure are described herein with reference to the accompanying drawings, wherein:

FIG. **1** is a perspective separated view of an adapter assembly, in accordance with an embodiment of the present disclosure, an extension assembly, in accordance with an embodiment of the present disclosure, and an exemplary electromechanical surgical device;

FIG. **2** is a perspective side view of the exemplary electromechanical surgical device of FIG. **1**;

FIG. **3** is a perspective side view of the adapter assembly of FIG. **1**;

FIG. **4** is a perspective side view of the adapter assembly of FIG. **3** with the outer sleeve removed;

FIG. **5** is a perspective side view of the adapter assembly of FIGS. **3** and **4** with proximal and distal housings of first and second pusher assemblies removed;

FIG. **6** is a cross-sectional side view of the adapter assembly of FIGS. **2-4** taken along line **6-6** in FIG. **3**;

FIG. **7** is a cross-sectional side view of the adapter assembly of FIGS. **2-5** taken along line **7-7** in FIG. **5**;

FIG. **8** is an enlarged, perspective view of a coupling assembly and a transfer assembly of the adapter assembly of FIGS. **2-7**;

FIG. **9** is a perspective side view of adapter assembly of FIGS. **2-7** with the housing assemblies removed;

FIG. **10** is an enlarged view of the indicated area of detail of FIG. **9**;

FIG. **11** is an enlarged view of the indicated area of detail of FIG. **6**;

FIG. **12** is an enlarged view of the indicated area of detail of FIG. **7**;

FIG. **13** is a perspective end view of the transfer assembly of FIG. **8**;

FIG. **14** is an enlarged view of the indicated area of detail of FIG. **6**;

FIG. **15** is an enlarged view of the indicated area of detail of FIG. **7**;

FIG. **16** is an enlarged view of the indicated area of detail of FIG. **9**;

FIG. **17** is a perspective side view of the extension assembly of FIG. **1**;

FIG. **18** is a perspective side view of an inner flexible band assembly of the extension assembly of FIG. **17**;

FIG. **19** is a perspective side view of an outer flexible band assembly of the extension assembly of FIG. **17**;

FIG. **20** is a perspective side view of the inner and outer flexible band assemblies of FIGS. **18** and **19** and an exploded view of a frame assembly of the extension assembly of FIG. **17**;

FIG. **21** is a perspective side view of the inner and outer flexible band assemblies and frame assembly of FIG. **20**;

FIG. **22** is an enlarged view of the indicated area of detail of FIG. **21**;

FIG. **23** is a front, perspective view of the inner and outer flexible band assemblies and frame assembly of FIG. **20**;

FIG. **24** is an enlarged view of the indicated area of detail of FIG. **23**;

FIG. **25** is a cross-sectional end view taken along line **25-25** of FIG. **17**;

FIG. **26** is a cross-sectional end view taken along line **26-26** of FIG. **17**;

FIG. **27** is an enlarged perspective side view of a distal end of the inner and outer flexible band assemblies and frame assembly of FIG. **20** including a proximal seal member and first and second distal seal members;

FIG. **28** is an exploded perspective view of the proximal seal member and first and second distal seal members of FIG. **27**;

FIG. **29** is an exploded view of a trocar assembly of the extension assembly of FIG. **17**;

FIG. **29**A is a perspective side view of a connector assembly of the extension assembly of FIG. **17**;

FIG. **29**B is a cross-section side view of the connector assembly of FIG. **29**A;

FIG. **30** is a perspective side view of the trocar assembly of FIG. **29**;

FIG. **31** is a cross-sectional side view taken along line **31-31** of FIG. **30**;

FIG. **32** is a cross-sectional top view taken along line **32-32** of FIG. **17**;

FIG. **33** is an enlarge cross-sectional view of the distal end of the extension assembly of FIG. **17**;

FIG. **34** is a perspective side view of the adapter assembly of FIG. **3** connected to the extension assembly of FIG. **17** and an end effector and an anvil assembly connected to the extension assembly;

FIG. **35**A is an enlarged cross-sectional top view of the indicated area of detail of FIG. **34**;

FIG. **35**B is an enlarged cross-sectional side view of the indicated area of detail in FIG. **34**;

FIG. **36** is a perspective side view of an adapter assembly according to another embodiment of the present disclosure;

FIG. **37** is a cross-sectional side view taken along line **37-37** of FIG. **36**;

FIG. **38** is an enlarged cross-sectional side view of the indicated area of detail of FIG. **37**;

FIG. **39** is an exploded perspective view of a pusher assembly of the adapter assembly of FIG. **36**;

FIG. **40** is a perspective side view of the pusher assembly of FIG. **39**;

FIG. **41** is a cross-sectional side view taken along line **41-41** of FIG. **40**;

FIG. **42** is a cross-sectional top view of the adapter assembly of FIG. **36** secured to the extension assembly of FIG. **17**;

FIG. **43** is an enlarged cross-sectional top view of the indicated area of detail of FIG. **42**, prior to full securement of the extension assembly to the adapter assembly;

FIG. **44** is an enlarged cross-sectional top view of the indicated area of detail of FIG. **42**, with the extension assembly secured to the adapter assembly; and

FIG. **45** is a perspective side view of the adapter assembly and extension assembly of FIG. **42**, with outer sleeves removed.

DETAILED DESCRIPTION OF EMBODIMENTS

Embodiments of the presently disclosed adapter assemblies and extension assemblies for surgical devices and/or handle assemblies are described in detail with reference to the drawings, in which like reference numerals designate identical or corresponding elements in each of the several views. As used herein the term "distal" refers to that portion of the adapter assembly or surgical device, or component thereof, farther from the user, while the term "proximal" refers to that portion of the adapter assembly or surgical device, or component thereof, closer to the user.

With reference to FIG. **1**, an adapter assembly in accordance with an embodiment of the present disclosure, shown generally as adapter assembly **100**, is configured for selective connection to a powered handheld electromechanical instrument shown, generally as surgical device **10**. As illustrated in FIG. **1**, the surgical device **10** is configured for selective connection with the adapter assembly **100**, and, in turn, the adapter assembly **100** is configured for selective connection with an extension assembly **200**. The extension assembly **200** is configured for selective connection with a tool assembly or end effector, e.g. tool assembly **30** (FIG. **34**), including a loading unit, e.g. loading unit **40** (FIG. **34**), and an anvil assembly, e.g., anvil assembly **50** (FIG. **34**), for applying a circular array of staples (not shown) to tissue (not shown).

As illustrated in FIGS. **1** and **2**, the surgical device **10** includes a handle housing **12** having a lower housing portion **14**, an intermediate housing portion **16** extending from and/or supported on the lower housing portion **14**, and an upper housing portion **18** extending from and/or supported on the intermediate housing portion **16**. A distal half-section of the upper housing portion **18** defines a nose or connecting portion **18***a* configured to accept a corresponding drive coupling assembly **110** (FIG. **10**) of the adapter assembly **100**. For a detailed description of the structure and function of an exemplary electromechanical instrument, please refer to commonly owned U.S. Pat. Appl. Publ. No. 2012/0253329 ("the '329 application"), the contents of which is incorporated by reference herein in its entirety.

The adapter assembly **100** will now be described with reference to FIGS. **3-20**. Referring initially to FIG. **3**, the adapter assembly **100** includes a proximal end **102** configured for operable connection to the connecting portion **18***a* (FIG. **1**) of the surgical device **10** (FIG. **1**) and a distal end **104** configured for operable connection to the extension assembly **200** (FIG. **1**).

Turning to FIGS. **3-5**, from the proximal end **102** to the distal end **104** of the adapter assembly **100**, the adapter assembly **100** includes a drive coupling assembly **110**, a drive transfer assembly **130** operably connected to the drive coupling assembly **110**, a first pusher assembly **160** operably connected to the drive transfer assembly **130**, and a second pusher assembly **180** operably connected to the drive transfer assembly **130**. Each of the drive transfer assembly **130** and the first and second pusher assemblies **160**, **180** are operably maintained within an outer sleeve **106** (FIG. **3**). As will be described in further detail below, a shaft **108** (FIG.

3) extends longitudinally through the adapter assembly **100** and is operably connected to the drive transfer assembly **130**.

With reference to FIGS. **5-9**, the drive coupling assembly **110** has a cylindrical profile and is configured to selectively secure the adapter assembly **100** to the surgical device **10** (FIG. **1**). The drive coupling assembly **110** includes a connector housing **112** and a connector extension **114** fixedly connected to the connector housing **112** by a mounting plate **113**. The connector housing **112** and the connector extension **114** operate to rotatably support a first rotatable proximal drive shaft **116**, a second rotatable proximal drive shaft **118**, and a third rotatable proximal drive shaft **120**. The connector housing **112** and the connector extension **114** of the drive coupling assembly **110** also rotatably support the first, second, and third connector sleeves **116**, **118**, and **120**, respectively. Each of the connector sleeves **122**, **124**, **126** is configured to mate with the respective first, second, and third drive connectors (not shown) of surgical device **10** (FIG. **1**). Each of the connector sleeves **122**, **124**, **126** is further configured to mate with a proximal end **116***a*, **118***a*, **120***a* of the respective first, second and third proximal drive shafts **116**, **118**, **120**.

The drive coupling assembly **110** also includes first, second and third biasing members **122***a*, **124***a* and **126***a* disposed distally of the respective first, second and third connector sleeves **122**, **124**, **126**. Each of the biasing members **122***a*, **124***a* and **126***a* is disposed about the respective first, second, and third rotatable proximal drive shafts **116**, **118** and **120** to help maintain the connector sleeves **122**, **124**, and **126** engaged with the distal end of the respective rotatable drive connectors (not shown) of the surgical device **10** when the adapter assembly **100** is connected to the surgical device **10**. In particular, the first, second, and third biasing members **122***a*, **124***a*, and **126***a* function to bias the respective connector sleeves **122**, **124**, and **126** in a proximal direction.

For a detailed description of an exemplary drive coupling assembly, please refer to the '329 application, the contents of which were previously incorporated by reference herein.

With reference to FIGS. **9-13**, the drive transfer assembly **130** has a cylindrical profile and operably connects the distal ends of the first, second, and third rotatable proximal drive shafts **116**, **118**, and **120** to the shaft **108**, the first pusher assembly **160**, and the second pusher assembly **180**, respectively. The drive transfer assembly **130** includes a support plate **132** (FIGS. **11** and **12**) secured to a proximal end of the connector housing **112** and a drive transfer housing **134** positioned adjacent the support plate **132**. The support plate **132** and the housing **134** operate to rotatably support a first rotatable distal drive shaft **136**, a second rotatable distal drive shaft **138** and a drive member **140**.

The first and second rotatable distal drive shafts **136** and **138** are each operably connected to the respective first and second rotatable proximal drive shafts **116** and **118** of the drive coupling assembly **110** by a pair of gears. In particular, the distal ends of each of the first and second rotatable proximal drive shaft **116** and **118** include a geared portion **142***a* and **144***a*, respectively, which engages a proximal drive gear **142***b* and **144***b* on a proximal end of the respective first and second distal drive shafts **136** and **138**. As shown, each of the respective paired geared portions and proximal drive gears **142***a*, **142***b* and **144***a*, **144***b* are the same size to provide a 1:1 gear ratio between the respective first and second rotatable proximal and distal drive shafts **116**, **136** and **118**, **138**. In this manner, the respective first and second rotatable proximal and distal drive shafts **116**, **136** and **118**, **138** rotate at the same speed. However, it is envisioned that either or both of the paired geared portions and proximal drive gears may be of different sizes to alter the gear ratio between the first and second rotatable proximal and distal drive shafts **116**, **136** and **118**, **138**.

A distal end of the third proximal drive shaft **120** of the drive coupling assembly **110** includes a geared portion **146***a* that engages a geared portion **146***b* formed on a proximal end of the drive member **140** of the drive transfer assembly **130**. The size of the geared portion **146***a* on the third proximal drive shaft **120** and the geared portion **146***b* on the drive member **140** are the same size to provide a 1:1 gear ratio between the third proximal drive shaft **120** and the drive member **140**. In this manner, the third proximal drive shaft **120** and the drive member **140** rotate at the same speed. However, it is envisioned that either or both of the geared portions **146***a*, **146***b* may be of different sizes to alter the gear ratio between the third proximal drive shaft **120** and the drive member **140**. A distal end of the drive member **140** defines a socket **145** that receives a proximal end **108***a* of the shaft **108**. Alternatively, the socket **145** may be configured to operably engage a proximal end **208***a* of a drive shaft (FIG. **17**) of an extension assembly **200** (FIG. **17**).

The drive transfer assembly **130** also includes a drive connector **148** (FIG. **11**) operably connecting the first rotatable distal drive shaft **136** to the first pusher assembly **160** and a tubular connector **150** operably connecting the second rotatable distal drive shaft **138** to the second pusher assembly **180**. In particular, a distal end of the first rotatable distal drive shaft **136** includes a geared portion **152***a* that engages a geared portion **152***b* of the drive connector **148**. A distal end of the second rotatable distal drive shaft **138** includes a geared portion **154***a* that engages a drive gear **154***b* secured to a distal end of the tubular connector **150**.

As shown, the geared portion **152***a* of the first rotatable distal drive shaft **136** is smaller than the geared portion **152***b* of the drive connector **148** to provide a gear ratio of greater than 1:1 between the first rotatable distal drive shaft **136** and the drive connector **148**. In this manner, the drive connector **148** rotates at a slower speed than the first rotatable distal drive shaft **136**. Similarly, the geared portion **154***a* of the second rotatable distal drive shaft **138** is smaller than the drive gear **154***b* on the tubular connector **150** to provide a gear ratio of greater than 1:1 between the second rotatable distal drive shaft **138** and the drive connector **148**. In this manner, the tubular connector **150** rotates at a slower speed than the second rotatable distal drive shaft **138**. However, it is envisioned that each of the paired geared portions **152***a*, **152***b*, and the geared portion **154***a* and the drive gear **154***b* may be the same size to provide a gear ratio of 1:1 between the respective first rotatable distal drive shaft **136** and the drive connector **148** and between the second rotatable distal drive shaft **138** and the tubular connector **150**.

With particular reference to FIGS. **9-13**, the first pusher assembly **160** includes proximal and distal housing sections **162**, **164** (FIG. **11**), a planetary gear assembly **166** operably mounted within the proximal housing section **162**, a screw member **168** (FIG. **11**) operably connected to the planetary gear assembly **166** and rotatably supported within the distal housing section **164**, and a pusher member **170** (FIG. **11**) operably connected to the screw member **168** and slidably disposed within the distal housing section **164**. The proximal housing section **162** includes a pair of longitudinal flanges **162***a* (FIG. **4**; only one shown) and the distal housing section **164** includes a pair of longitudinally flattened portions **164***a*. Each of the flanges **162***a* and the flattened portions **164***a* of the respective proximal and distal housing sections **162**, **164**

engage an inner surface of the sleeve **106** to prevent rotation of the respective proximal housing section **162** and the distal housing section **164** relative to the sleeve **106** during operation of the surgical device **10**.

The planetary gear assembly **166** includes first and second planetary gear systems **166***a*, **166***b* (FIG. **10**). The first planetary gear system **166***a* of the first pusher assembly **160** includes a central drive gear **172***a* mounted on a distal end of the drive connector **148** of the drive transfer assembly **130** and a plurality of planetary gears **174***a* rotatably mounted to a rotatable support ring **176**.

Each of the planetary gears **174***a* engages the central drive gear **172***a* and a toothed inner surface **165** of the proximal housing section **162**. As central drive gear **172***a* rotates in a first direction, i.e., clockwise, each of the planetary gears **174***a* rotates in a second direction, i.e., counter-clockwise. As each of the planetary gears **174***a* rotates in the second direction, engagement of the planetary gears **174***a* with the toothed inner surface **165** of the distal housing section **162** causes the rotatable support ring **176** to rotate in the first direction. Conversely, rotation of the central drive gear **172***a* in the second direction causes rotation of each of the planetary gears **174***a* in the first direction thereby causing rotation of the rotatable support ring **176** in the second direction. The configuration of the first planetary gear system **166***a* provides a reduction in the gear ratio. In this manner, the speed of rotation of the rotatable support ring **174** is less than the speed of rotation of the central drive gear **172***a*.

The second planetary gear system **166***b* of the first pusher assembly **160** includes a central drive gear **172***b* securely affixed to the rotatable support ring **176** and a plurality of planetary gears **174***b* rotatably mounted to a proximal end surface **168***a* of the screw member **168**. Each of the planetary gears **174***b* engages the central drive gear **172***b* and the toothed inner surface **165** of the proximal housing section **162**. As the rotatable support ring **176** of the first planetary gear system **166***a* rotates in the first direction thereby causing the central drive gear **172***b* to also rotate in the first direction, each of the planetary gears **174***b* rotates in the second direction. As each of the planetary gears **174***b* rotates in the second direction, engagement of the planetary gears **174***b* with the toothed inner surface **165** of the proximal housing section **162** causes the screw member **168** to rotate in the first direction. Conversely, rotation of the central drive gear **172***b* in the second direction causes rotation of each of the planetary gears **174***b* in the first direction, thereby causing the screw member **168** to rotate in the second direction. The configuration of the second planetary gear system **166***b* provides a reduction in the gear ratio. In this manner, the speed of rotation of the screw member **168** is less than the speed of rotation of the central drive gear **172***b*.

The first and second planetary gear systems **166***a*, **166***b* operate in unison to provide a reduction in the gear ratio between the first rotatable proximal drive shaft **116** and the screw member **168**. In this manner, the reduction in the speed of rotation of the screw member **168** relative to the drive connector **148** is a product of the reduction provided by the first and second planetary gear systems **166***a*, **166***b*.

The screw member **168** is rotatably supported within the proximal housing portion **162** and includes a threaded distal end **168***b* that operably engages a threaded inner surface **170***a* of the pusher member **170**. As the screw member **168** is rotated in the first direction, engagement of the threaded distal end **168***b* of the screw member **168** with the threaded inner surface **170***a* of the pusher member **170** causes longitudinal advancement of the pusher member **170**, as indicated by arrows "A" in FIG. **12**. Conversely, rotation of the screw member **168** in the second direction causes retraction of the pusher member **170**.

The pusher member **170** includes a pair of tabs **178** formed on a distal end thereof for engaging the connector extensions **240**, **242** (FIG. **19**) of the outer flexible band assembly **230** (FIG. **19**) of the extension assembly **200** (FIG. **17**). Although shown as tabs **178**, it is envisioned that the pusher member **170** may include any structure suitable for selectively engaging the connector extensions **240**, **242** of the outer flexible band **230** of the extension assembly **200**.

With particular reference now to FIGS. **14-16**, the second pusher assembly **180** is substantially similar to the first pusher assembly **160**, and includes proximal and distal housing sections **182**, **184**, a planetary gear assembly **186** operably mounted within the proximal housing section **182**, a screw member **188** operably connected to the planetary gear assembly **186** and rotatably supported within the distal housing section **184**, and a pusher member **190** operably connected to the screw member **188** and slidably disposed within the distal housing section **184**. Each of the proximal housing section **182** and the distal housing section **184** includes a pair of longitudinal flanges **182***a*, **184***a* (FIG. **4**; only one shown), respectively, engaging an inner surface of the sleeve **106** of the adapter assembly **100** to prevent rotation of the respective proximal housing section **182** and the distal housing section **184** relative to the sleeve **106** during operation of the surgical device **10**.

The planetary gear assembly **186** includes first and second planetary gear systems **186***a*, **186***b* (FIG. **16**). The first planetary gear system **186***a* of the second pusher assembly **180** includes a central drive gear **192***a* mounted on a distal end of the tubular connector **150** of the drive transfer assembly **130** and a plurality of planetary gears **194***a* rotatably mounted to a rotatable support ring **196**.

Each of the planetary gears **194***a* engages the central drive gear **192***a* and a toothed inner surface **185** of the proximal housing section **182**. As central drive gear **192***a* rotates in a first direction, i.e., clockwise, each of the planetary gears **194***a* rotates in a second direction, i.e., counter-clockwise. As each of the planetary gears **194***a* rotates in the second direction, engagement of the planetary gears **194***a* with toothed inner surface **185** of the distal housing section **182** causes the rotatable support ring **196** to rotate in the first direction. Conversely, rotation of the central drive gear **192***a* in the second direction causes rotation of each of the planetary gears **194***a* in the first direction thereby causing rotation of the rotatable support ring **196** in the second direction. The configuration of the first planetary gear system **186***a* provides a reduction in the gear ratio. In this manner, the speed of rotation of the rotatable support ring **194** is less than the speed of rotation of the central drive gear **190***a*.

The second planetary gear system **186***b* of the second pusher assembly **180** includes a central drive gear **192***b* securely affixed to the rotatable support ring **196** and a plurality of planetary gears **194***b* rotatably mounted to a proximal end surface **188***a* of the screw member **188**. Each of the planetary gears **194***b* engages the central drive gear **192***b* and the toothed inner surface **185** of the proximal housing section **182**. As the rotatable support ring **196** of the first planetary gear system **186***a* rotates in the first direction thereby causing the central drive gear **192***b* to also rotate in the first direction, each of the planetary gears **174***b* rotates in the second direction. As each of the planetary gears **194***b* rotates in the second direction, engagement of the planetary gears **194***b* with the toothed inner surface **185** of the proxi-

mal housing section **182** causes the screw member **188** to rotate in the first direction. Conversely, rotation of the central drive gear **192***b* in the second direction causes rotation of each of the planetary gears **194***b* in the first direction, thereby causing the screw member **198** to rotate in the second direction. The configuration of the second planetary gear system **186***b* provides a reduction in the gear ratio. In this manner, the speed of rotation of the screw member **188** is less than the speed of rotation of the central drive gear **182***b*. The first and second planetary gear systems **186***a*, **186***b* operate in unison to provide a reduction in the gear ratio between the second rotatable proximal drive shaft **118** and the screw member **188**. In this manner, the reduction in the speed of rotation of the screw member **188** relative to the tubular connector **150** is a product of the reduction provided by the first and second planetary gear systems **186***a*, **186***b*.

The screw member **188** is rotatably supported within the proximal housing portion **182** and includes a threaded distal end **188***b* that operably engages a threaded inner surface **190***a* of the pusher member **190**. As the screw member **188** is rotated in the first direction, engagement of the threaded distal end **188***b* of the screw member **188** with the threaded inner surface **190***a* of the pusher member **190** causes longitudinal advancement of the pusher member **190**. Conversely, rotation of the screw member **188** in the second direction causes retraction of the pusher member **190**. The pusher member **190** includes a pair of longitudinal flanges **191** (FIG. **5**; only one shown) that engage the distal housing section **184** of the second pusher assembly **180** for preventing rotation of the pusher member **190** relative to the distal housing section **184**.

The pusher member **190** includes a pair of tabs **198** formed on a distal end thereof for engaging the connector extensions **220**, **224** (FIG. **18**) of the inner flexible band assembly **220** (FIG. **18**) of the extension assembly **200** (FIG. **17**). Although shown as tabs **198**, it is envisioned that the pusher member **190** may include any structure suitable for selectively engaging the connector extensions **240**, **242** of the outer flexible band **230** of the extension assembly **200**.

The extension assembly **200** for operably connecting the adapter assembly **100** (FIG. **3**) with a circular loading unit, e.g. the loading unit **40** (FIG. **34**) and an anvil assembly, e.g., the anvil assembly **50** (FIG. **34**) will be described with reference now to FIGS. **17-34**. In particular, a proximal end **202** of the extension assembly **200** operably connects with the distal end **104** (FIG. **3**) of the adapter assembly **100** (FIG. **3**) and a distal end **204** of the extension assembly **200** operably connects with the loading unit **40** and the anvil assembly **50**. As shown, the extension assembly **200** provides a slight curvature between the proximal and distal ends **202**, **204**. In an alternative embodiment, the extension assembly **200** may be straight or may include a greater curvature. Although the extension assembly **200** will be shown and described as being used to connect the loading unit **40** and the anvil assembly **50** to the adapter assembly **100** (FIG. **3**), it is envisioned that the aspects of the present disclosure may be modified for use with various loading units, anvil assemblies, and adapter assemblies. Exemplary loading units and anvil assemblies are described in commonly owned U.S. Pat. No. 8,590,763 and U.S. patent application Ser. Nos. 14/056,301 and 14/149,355, the contents of each being incorporated herein by reference in their entirety.

The extension assembly **200** includes an inner flexible band assembly **210** (FIG. **18**), an outer flexible band assembly **230** (FIG. **19**) slidably disposed about the inner flexible band assembly **210**, a frame assembly **250** (FIG. **20**) for supporting the inner and outer flexible band assemblies **210**, **230**, a trocar assembly **270** (FIG. **28**) operably received through the inner and outer flexible band assemblies **210**, **230**, and a connector assembly **290** for securing the loading unit **40** (FIG. **34**) to the extension assembly **200**. An outer sleeve **206** (FIG. **17**) is received about the frame assembly **250** and the trocar assembly **270** and the inner and outer flexible band assemblies **210**, **230** are slidably received through the outer sleeve **206**. As will be described in further detail below, the extension assembly **200** may include a drive shaft **208** operably connected to the trocar assembly **270** and extending through the proximal end **202** of the extension assembly **200**.

With reference to FIG. **18**, the inner flexible band assembly **210** includes first and second inner flexible bands **212**, **214**, a support ring **216**, a support base **218**, and first and second connection extensions **220**, **222**. The proximal ends **212***a*, **214***a* of the respective first and second inner flexible bands **212**, **214** are laterally spaced apart and securely attached to the support ring **216**. The distal ends **212***b*, **214***b* of the first and second inner flexible bands **212**, **214** are laterally spaced apart and securely attached to a proximal end **218***a* of the support base **218**. Each of the first and second inner flexible bands **212**, **214** may be attached to the support ring **216** and/or the support base **218** in any suitable manner, including, for example, by press-fitting, welding, adhesives, and/or with mechanical fasteners. As will be described in further detail below, the inner flexible band assembly **210** is configured to be slidably received about the trocar assembly **270** (FIG. **28**) and within the outer flexible band assembly **230** (FIG. **19**) and the outer sleeve **206** (FIG. **17**).

The first and second connection extensions **220**, **222** of the inner flexible band assembly **210** extend proximally from the support ring **216** and operably connect the inner flexible band assembly **210** with the pusher member **190** (FIG. **15**) of the second pusher assembly **180** (FIG. **15**) of the adapter assembly **100** (FIG. **3**). In particular, each of the first and second connection extensions **220**, **222** define openings **221**, **223** configured to receive tabs **198** (FIG. **15**) of the pusher member **190** (FIG. **15**) of the second pusher assembly **180**. Receipt of the tabs **198** of the pusher member **190** within the openings **221**, **223** of the respective first and second extensions **220**, **222** secure the inner flexible band assembly **210** of the extension assembly **200** with the second pusher assembly **180** of the adapter assembly **100**. The first and second connection extensions **220**, **222** may be integrally formed with the support ring **216**, or attached thereto in any suitable manner.

The support base **218** extends distally from the inner flexible bands **212**, **214** and is configured to selectively connect the extension assembly **200** with the loading unit **40** (FIG. **34**). Specifically, a distal end **218***a* of the support base **218** includes a flange **224** for operable engagement with an axially movable assembly (not shown) of the loading unit **40** (FIG. **34**). In one embodiment, the flange **224** is configured for connection with a knife assembly (not shown) of the loading unit **40** (FIG. **34**).

With reference now to FIG. **19**, the outer flexible band assembly **230** is substantially similar to the inner flexible band assembly **210** and includes first and second flexible bands **232**, **234** laterally spaced and connected on proximal ends **232***a*, **234***a* to a support ring **236** and on distal ends **234***b*, **234***b* to a proximal end **238***a* of a support base **238**. Each of the first and second outer flexible bands **232**, **234** may be attached to the support ring **236** and the support base **238** in any suitable manner, including, for example, by

press-fitting, welding, adhesives, and/or with mechanical fasteners. As will be described in further detail below, the outer flexible band assembly **230** is configured to receive the trocar assembly **270** (FIG. **28**) therethrough.

The first and second connection extensions **240**, **242** of the outer flexible band assembly **230** extend proximally from the support ring **236** and operably connect the outer flexible band assembly **230** with the pusher member **170** (FIG. **12**) of the first pusher assembly **160** (FIG. **12**) of the adapter assembly **100** (FIG. **1**). In particular, each of the first and second connection extensions **240**, **242** define openings **241**, **243** configured to receive the tabs **178** (FIG. **12**) of the pusher member **170** of the first pusher assembly **180**. Receipt of the tabs **178** of the pusher member **170** within the openings **241**, **243** of the respective first and second extensions **240**, **242** secures the outer flexible band assembly **230** of the extension assembly **200** with the first pusher assembly **180** of the adapter assembly **100**. The first and second connection extensions **240**, **242** may be integrally formed with the support ring **236**, or attached thereto in any suitable manner.

The support base **238** extends distally from the outer flexible bands **232**, **234** and is configured to selectively connect the extension assembly **200** with the loading unit **40** (FIG. **34**). Specifically, a distal end **238***b* of the support base **238** includes a flange **244** for operable engagement with an axially movable assembly (not shown) of a loading unit (not shown). In one embodiment, the flange **244** is configured for connection with a staple pusher assembly (not shown) of the loading unit **40** (FIG. **34**).

With reference now to FIGS. **20-26**, the frame assembly **250** includes first and second proximal spacer members **252**, **254**, and first and second distal spacer members **256**, **258**. When secured together, the first and second proximal spacer members **252**, **254** define a pair of inner longitudinal slots **253***a* for slidably receiving the first and second flexible bands **212**, **214** (FIG. **18**) of the inner flexible band assembly **210** (FIG. **18**) and a pair of outer longitudinal slots **253***b* for slidably receiving the first and second flexible bands **232**, **234** (FIG. **19**) of the outer flexible band assembly **230** (FIG. **19**). The first and second proximal spacer members **252**, **254** further define a longitudinal passage **255** for receipt of the trocar assembly **270**.

In one embodiment, and as shown, the first and second proximal spacer members **252**, **254** are formed of plastic and are secured together with a snap-fit arrangement. Alternatively, the first and second proximal spacer members **252**, **254** may be formed of metal or other suitable material and may be secured together in any suitable manner, including by welding, adhesives, and/or using mechanical fasteners.

The first and second distal spacer members **256**, **258** define a pair of inner slots **257***a* for slidably receiving the first and second flexible bands **212**, **214** (FIG. **18**) of the inner flexible band assembly **210** (FIG. **18**) and a pair of outer slots **257***b* for slidably receiving the first and second flexible bands **232**, **234** (FIG. **19**) of the outer flexible band assembly **230** (FIG. **19**). The first and second distal spacer members **256**, **258** further define a longitudinal passage **259** for receipt of the trocar assembly **270**.

In one embodiment, and as shown, each of the first and second distal spacer members **256**, **258** are secured about the inner and outer flexible band assemblies **210**, **230** and to the outer sleeve **206** (FIG. **17**) by a pair of screws **260***a*, **260***b* (FIG. **26**). Alternatively, the first and second distal spacer members **256**, **258** may be secured together in any suitable manner, including by welding, adhesives, and/or using mechanical fasteners. The first and second distal spacer members **256**, **258** may be formed of metal or any other suitable material.

With reference now to FIGS. **27** and **28**, the frame assembly **250** further includes a proximal seal member **262** and first and second distal seal members **264**, **266**. Each of the proximal seal member **252** and the first and second distal seal members **264**, **266** include seals halves **262***a*, **262***b*, **264***a*, **264***b*, **266***a*, **266***b*, respectively. The proximal seal member **262** is received between the first and second proximal spacer members **252**, **254** and the first and second distal spacer members **256**, **258**. The first half **264***a* of the first distal seal member **264** is secured to the first half **266***a* of the second distal seal member **266** and the second half **264***b* of the first distal seal member **264** is secured to the second half **266***b* of the second distal seal member **266**. The proximal seal member **262** and the first and second distal seal members **264**, **266** engage the outer sleeve **206** (FIG. **17**), the inner and outer flexible bands **212**, **214**, **232**, **234** of the respective inner and outer flexible band assemblies **210**, **230** and the trocar assembly **270** (FIG. **28**) in a sealing manner. In this manner, the proximal seal member **262** and the first and second distal seal members **264**, **266** operate to provide a fluid tight seal between the distal end **204** and the proximal end **202** of the extension assembly **200**.

With reference to FIGS. **29-32**, the trocar assembly **270** of the extension assembly **200** includes an outer housing **272**, a trocar member **274** slidably disposed within the tubular outer housing **272**, and a drive screw **276** operably received within the trocar member **274** for axially moving the trocar member **274** relative to the tubular housing **272**. In particular, the trocar member **274** includes a proximal end **274***a* having an inner threaded portion **275** which engages a threaded distal portion **276***b* of the drive screw **276**. As the drive screw **276** is rotated within the trocar member **274**, engagement of the inner threaded portion **275** of the trocar member **274** with the threaded distal portion **276***b* of the drive screw **276** causes longitudinal movement of the trocar member **274** within the outer housing **272** of the trocar assembly **270**. Rotation of the drive screw **276** in a first direction causes longitudinal advancement of the trocar member **274** and rotation of the drive screw **276** in a second direction causes longitudinal retraction of the trocar member **274**. A distal end **274***b* of the trocar member **274** is configured to selectively engage the anvil assembly **50** (FIG. **34**).

A bearing assembly **278** is mounted to a proximal end **272***a* of the outer housing **272** of the trocar assembly **270** for rotatably supporting a proximal end **276***a* of the drive screw **276** relative to the outer housing **272** and the trocar member **274**. The bearing assembly **278** includes a housing **278***a*, proximal and distal spacers **278***b*, proximal and distal retention clips **278***c*, proximal and distal bearings **278***d*, and a washer **278***e*. As shown, the proximal end **276***a* of the drive screw **276** includes a flange **276***c* for connection with a link assembly **280**.

The link assembly **280** operably connects the transfer assembly **130** (FIG. **6**) of the adapter assembly **100** with the trocar assembly **270** (FIG. **30**) of the extension assembly **200**. More particularly, the link assembly **280** transfers rotational energy from the drive member **140** (FIG. **6**) of the transfer assembly **130** of the adapter assembly **100** through the curved outer tube **206** (FIG. **17**) of the extension assembly **200** to the flange **276***c* (FIG. **29**) on the proximal end **276***a* of the drive screw **276** of the trocar assembly **270** of the extension assembly **200**.

With reference to FIGS. **29**A and **29**B, the link assembly **280** includes a coupling member **282**, a first drive shaft **284**,

and a second drive shaft **286**. A proximal end **282***a* of the coupling member **282** defines a recess **283***a* for receiving a distal end **284***b* of the first drive shaft **284**. A distal end **282***b* of the coupling member **282** defines a recess **283***a* for operably receiving the flange **276***c* on the proximal end **276***a* of the drive screw **276**. The coupling member **282** includes an annular flange **282***c* for rotatably receiving the coupling member **282** between the first and second proximal spacer members **252**, **254** (FIG. **32**). The proximal and distal ends **284***a*, **284***b* of the first drive shaft **284** define oversized openings **285***a*, **285***b*, respectively, for receiving pins **288***a*, **288***b*, respectively. A distal end **286***b* of the second drive shaft **286** defines a recess **287** for operably receiving the proximal end **284***a* of the drive shaft **284**. A proximal end **286***a* of the drive shaft **286** includes a flange **286***c* for operable receipt within the socket **145** of the drive member **140** of the drive transfer assembly **130** of the adapter assembly **100** (FIG. **12**).

With particular reference to FIG. **29**B, the proximal end **284***a* of the first drive shaft **284** is operably received within the recess **285** in the distal end **286** of the second drive shaft **286**. The distal end **284***b* of the first drive shaft **284** is pivotally secured within the recess **283***a* of the coupling member **282** by the pin **288***a* received through the oversized opening **285***b* in the distal end **284***b* of the first drive shaft **284**. The proximal end **284***a* of the first drive shaft **284** is pivotally secured within the recess **287** in the distal end **286***b* of the second drive shaft **286** by the pin **288***b* received through the oversized opening **285***a* in the proximal end **284***a* of the first drive shaft **284**. The recesses **283***a* and **287** of the coupling member **282** and the second drive shaft **286**, respectively, and the oversized openings **285***a*, **285***b* of the first drive shaft **284** are configured to permit pivoting of the second drive shaft **286** relative to the first drive shaft **284** and pivoting of the first drive shaft **284** relative to the coupling member **282** as each of the first and second drive shafts **284**, **286**, and the coupling member **282** are rotated about their respective longitudinal axes to transfer rotational force from the transfer assembly **130** (FIG. **6**) of the adapter assembly **100** to the trocar assembly **270** (FIG. **30**) of the extension assembly **200**.

With reference now to FIGS. **32** and **33**, the connector assembly **290** of the extension assembly **200** includes a tubular connector **292** attached to a distal end **206***a* of the outer sleeve **206** and about distal ends of the inner and outer flexible assemblies **210**, **230** (FIG. **26**) and the trocar assembly **270**. In particular, a proximal end **292***a* of the tubular connector **292** is received within and securely attached to the distal end **206***b* of the outer sleeve **206** by a retaining clip **294**. An O-ring **296** forms a fluid tight seal between the tubular connector **292** of the connector assembly **290** and the outer sleeve **206**. A distal end **292***b* of the tubular connector **292** is configured to selectively engage a proximal end of the loading unit **40** (FIG. **34**). The distal end **292***b* of the tubular connector **292** engages the circular loading unit **40** with a snap-fit arrangement, bayonet coupling, or in another suitable manner.

With reference now to FIGS. **34** and **35**, the extension assembly **200** is connected to the adapter assembly **100** by receiving the proximal end **202** (FIG. **17**) of the extension assembly **200** within the distal end **104** of the adapter assembly **100**. In particular, the first and second connection extensions **220**, **222**, **240**, **242** of respective inner and outer flexible band assemblies **210**, **230** are received within the sleeve **106** of the adapter assembly **100** such that tabs **178** of the pusher member **170** of the first pusher assembly **160** of the adapter assembly **100** are received within the openings **241**, **243** of the respective first and second connection extensions **240**, **242** of the outer flexible band assembly **230**. In this manner, the outer flexible band assembly **230** is secured with the first pusher assembly **160**. Additionally, the tabs **198** of the pusher member **190** of the second pusher assembly **180** of the adapter assembly **100** are received within the openings **221**, **223** of the first and second connection extensions **221**, **223** of the inner flexible band assembly **210** to secure the inner flexible band assembly **210** with the second pusher assembly **180**.

As noted above, adapter assembly **100** may include a drive shaft **108** (FIG. **3**) that extends from the distal end **104** of the adapter assembly **100**. Prior to receipt of the proximal portion **202** of the extension assembly **200** within the distal end **104** of the extension assembly **100**, the drive shaft **108** is removed from the adapter assembly **100**. As the proximal portion **202** of the extension assembly **200** is received within the distal end **102** of the adapter assembly **100**, the proximal end **286***a* (FIG. **17**) of the second drive shaft **286** (FIG. **17**) is received within the socket **145** of the drive member **140** of the drive transfer assembly **130** of the extension assembly **100** (FIG. **12**).

After the extension assembly **200** is operably engaged with the adapter assembly **100**, and the adapter assembly **100** is operably engaged with the surgical device **10** (FIG. **1**), the loading unit **40** (FIG. **34**) of the end effector **30** (FIG. **34**) may be attached to the connector assembly **290** of the extension assembly **200** and an anvil assembly **50** (FIG. **34**) may be attached to the distal end **274***b* of the trocar **274** of the extension assembly **200** in a conventional manner. During actuation of the loading unit **40** and the anvil assembly **50**, longitudinal advancement of the pusher member **190** of the second pusher assembly **180** of the adapter assembly **100**, as described above, and as indicated by arrows "C" in FIG. **35**, causes longitudinal advancement of the outer flexible band assembly **230** of the extension assembly **200** and longitudinal advancement of the pusher member **170** of the first pusher assembly **160**, as described above, and as indicated by arrows "D" in FIG. **35**, causes longitudinal advancement of the inner flexible band assembly **210**. Rotation of the drive shaft **108** in a first direction, as described above, and as indicated by arrow "E", causes advancement of the trocar **274** of the extension assembly **200**. Conversely, longitudinal retraction of the pusher member **190** causes longitudinal retraction of the outer flexible band assembly **230**, longitudinal retraction of the pusher member **170** causes longitudinal retraction of the inner flexible band assembly **210**, and rotation of the drive shaft **108** in a second direction causes retraction of the trocar **274** of the extension assembly **200**.

In embodiments, the inner flexible band assembly **210** operably connects the second pusher assembly **180** of the adapter assembly **100** with a knife assembly (not show) of the loading unit **40** (FIG. **34**) of the end effector **30** (FIG. **34**) attached to the connection assembly **290** of the extension assembly **200**. The outer flexible band assembly **230** operably connects the first pusher assembly **160** of the adapter assembly **100** with a staple driver assembly (not shown) of the loading unit **40**. The trocar assembly **270** operably connects the drive transfer assembly **130** of the adapter assembly **100** to the anvil assembly **50** (FIG. **34**) of the end effector **30** (FIG. **34**). In this manner, operation of the second pusher assembly **160** causes longitudinal movement of the inner flexible band assembly **210** which causes longitudinal movement of the knife assembly, operation of the first pusher assembly **180** causes longitudinal movement of the outer flexible band assembly **230** which causes longitudinal

movement of the staple driver assembly, and operation of the drive transfer assembly **130** causes longitudinal movement of the trocar **274** which causes longitudinal movement of the anvil assembly **50** relative to the loading unit **40**.

By stacking the first and second pusher assemblies **160**, **180** of the adapter assembly **100**, as described, and positioning the drive shaft **108** of the transfer assembly **130** through the first and second pusher assemblies **160**, **180**, the adapter assembly **100** can perform three functions through an access port or other opening (not shown) having a small diameter, e.g., 21 mm. Similarly, by configuring the inner flexible band assembly **210** within the outer flexible band assembly **230** and receiving the trocar assembly **270** through the inner and outer flexible band assemblies **210**, **230**, the extension assembly **200** can perform three functions through an access port or other opening (not shown) having a small diameter, e.g., 21 mm.

With reference now to FIGS. **36-45**, an adapter assembly according to another embodiment of the present disclosure is shown as adapter assembly **300**. Adapter assembly **300** is substantially similar to adapter assembly **100** described hereinabove and will only be described as relates to the differences therebetween.

As will become apparent from the following description, the configuration of adapter assembly **300** permits rotation of a distal portion **304** of adapter assembly **300** about a longitudinal axis "x" (FIG. **37**), relative to a proximal portion **302** of adapter assembly **300**. In this manner, an end effector, e.g. the end effector **30** (FIG. **34**) secured to the distal portion **304** of the adapter assembly **300** or an end effector secured to an extension assembly, e.g., the extension assembly **200** (FIG. **17**) which is secured to the distal portion **304** of the adapter assembly **300** is rotatable about the longitudinal axis "x" independent of movement of the surgical device (not shown) to which the adapter assembly **300** is attached.

With particular reference to FIG. **37**, the adapter assembly **300** includes a base **306** and a support structure **308** rotatable relative to the base **306** along the longitudinal axis "x" of the adapter assembly **300**. A rotation handle **310** is rotatably secured to the base **306** and is fixedly secured to a proximal end of support structure **308**. The rotation handle **310** permits longitudinal rotation of the distal portion **304** of the adapter assembly **300** relative to the proximal end **302** of the adapter assembly **300**. A latch **312** (FIG. **36**) is mounted to the rotation handle **310** and selectively secures the rotation handle **310** in a fixed longitudinal position.

With reference still to FIG. **37**, the proximal portion **302** of the adapter assembly **300** includes a drive coupling assembly **320** and a drive transfer assembly **330** operably connected to the drive coupling assembly **320**. The distal portion **304** of the adapter assembly **300** includes a first pusher assembly **340** operably connected to the drive transfer assembly **330**, and a second pusher assembly **380** operably connected to the drive transfer assembly **330**. The drive coupling assembly **320** and the drive transfer assembly **330** are mounted within the base **306** and remain rotationally fixed relative to the surgical device (not shown) to which the adapter assembly **300** is attached. The first pusher assembly **340** and the second pusher assembly **380** are mounted within the support structure **308** and are rotatable relative to the surgical device (not shown) to which the adapter assembly **300** is attached.

The drive coupling assembly **320** is configured to selectively secure adapter assembly **300** to a surgical device (not shown). For a detailed description of an exemplary surgical device and drive coupling assembly, please refer to commonly owned U.S. patent application Ser. No. 14/550,183, filed Nov. 21, 2014, the content of which is incorporated by reference herein in its entirety.

With continued reference to FIGS. **36** and **37**, the rotation handle **310** of the adapter assembly **300** is rotatably secured to the base **306**. The latch **312** is configured to lock the rotation handle **310** relative to the base **306**. Proximal movement of the latch **312**, as indicated by arrow "F" in FIG. **36**, disengages the latch **312** from the base **306** to permit rotation of the rotation handle **310** relative to the base **306**. For a detailed description of an exemplary rotation handle and latch mechanism, please refer to commonly owned U.S. Provisional Patent Application Ser. No. 62/066,518, the content of which is incorporated by reference herein in its entirety.

The support structure **308** is fixedly received about the first and second drive pusher assemblies **340**, **380** and is rotatable relative to the base **306**. As noted above, the rotation handle **310** is fixedly secured to the proximal end of the support structure **308** to facilitate rotation of the support structure **308** relative to the base **306**. The support structure **308** is retained within the outer sleeve **305** of the adapter assembly **300** and is configured to maintain axial alignment of the first and second drive pusher assemblies **340**, **380**. For a detailed description of an exemplary support structure, please refer to commonly owned U.S. Provisional Patent Application Ser. No. 62/066,518, the content of which was previously incorporated by reference herein.

The drive transfer assembly **330**, the first pusher assembly **340**, and the second drive pusher assembly **380** of the adapter assembly **300** are substantially identical to the respective drive transfer assembly **130**, first pusher assembly **160**, and second drive pusher assembly **180** of the adapter assembly **100** described hereinabove, and therefore, will only be described as relates to the differences therebetween.

Briefly, the first pusher assembly **340** includes a planetary gear assembly **346** operably supported within a proximal housing section **342** and a screw member **348** operably connected to the planetary gear assembly **346** and rotatably supported within a distal housing section **344**. The first pusher assembly **340** further includes a pusher member **350** operably connected to the screw member **348** and slidably disposed within the distal housing section **344**.

With particular reference to FIGS. **38-41**, the pusher member **350** includes a substantially cylindrical body **352** having a threaded proximal inner surface **352***a* and opposed planar outer surfaces **354**, **356**. Retainers **358**, **360** extend from the respective planar outer surfaces **354**, **356**. Each of the retainers **358**, **360** includes a pair of elongate flanges **358***a*, **358***b*, **360***a*, **360***b*, respectively, and a connector **358***c*, **360***c*, respectively, connecting a proximal end of the elongate flanges **358***a*, **358***b*, **360***a*, **360***b*, respectively. Each of the retainers **358**, **360** defines a longitudinal slot **359**, **361**, respectively, between respective elongate flanges **358***a*, **358***b*, **360***a*, **360***b*.

A pawl assembly **362**, **364** is received within each of the longitudinal slots **359**, **361**, respectively. The pawl assemblies **362**, **364** each include a plurality of pawl members **362***a-e*, **364***a-e*, respectively (collectively, pawls **366**, **368**, respectively), and pivot pins **363**, **365**. The pawls **366**, **368** are secured within the respective longitudinal slots **359**, **361** by the pivot pins **363**, **365**, respectively, received through openings **367**, **369**, respectively, formed in the respective distal ends **366***b*, **368***b* of the pawls **366**, **368**, respectively. The pawls **366**, **368** each include a curved profile and are formed of a resilient material. Protrusions **370**, **372** are formed on an outer curved surface of the respective pawls

366, 368 proximal to the distal ends 366*b*, 368*b*, respectively. The protrusions 370, 372 each include a flat proximal facing surface 370*a*, 372*a*, respectively, and a slanted or inclined distal facing surface 370*b*, 372*b*. As will be described in further detail below, the protrusions 370, 372 are configured to be received within openings 241, 243 (FIG. 43) of respective connector extensions 240, 242 (FIG. 43) of outer flexible band 230 (FIG. 42) of the extension assembly 200 (FIG. 42) to secure the outer flexible band 230 to the pusher member 350 of the first pusher assembly 340 when the extension assembly 200 is secured to the adapter assembly 300.

With particular reference to FIGS. 40 and 41, the pawls 366, 368 of the pawl assemblies 362, 364, respectively, are received within respective longitudinal slots 359, 361 of retainers 358, 360, respectively, with the respective distal ends 366*b*, 368*b* secured to retainers 358, 360, respectively, by pivot pins 363, 365, respectively. The proximal ends 366*a*, 368*a* of the pawls 366, 368, respectively, are received under the respective connectors 358*c*, 360*c* of the retainers 358, 360, respectively, and engage the planar surfaces 354, 356, respectively, of the cylindrical body 352 of the pusher member 350. The pawls 366, 368 are configured such that the protrusions 370, 372, respective, extend above the elongate flanges 358*a*, 358*b*, 360*a*, 360*b*, respectively, of the retainers 358, 360, respectively, when the respective pawls 366, 368 are in a first or initial position (FIG. 40).

With reference now to FIGS. 42 and 43, the curved profile of pawls 366, 368 is such that an inward force applied to the protrusions 370, 372, respectively, when the respective inclined distal surfaces 370*b*, 372*b* are engaged by connector extensions 240, 242, respectively, of outer flexible band 230 (FIG. 42) of the extension assembly 200 (FIG. 42) cause the pawls 366, 368 to flex inwardly. As the pawls 366, 368 flex inwardly the protrusions 370, 372, respectively, are positioned below the respective retainers 358, 360, thereby allowing connector extensions 240, 242 of outer flexible band 230 to pass over the respective retainers 358, 360. Once the openings 241, 243 of respective connector extensions 240, 242 align with the protrusions 370, 372, respectively, of the respective pawls 366, 368, the pawls 366, 368, respectively spring back to the initial position (FIG. 45), causing the protrusions 370, 372, respectively, to be received within the respective openings 241, 243 of the connector extensions 240, 242, respectively, such that the outer flexible band 230 (FIG. 42) of the extension assembly 200 (FIG. 42) is secured to the first pusher member 340.

Once the connector extensions 240, 242 of the outer flexible band 230 of the extension assembly 200 are received over the pawls 366, 368, respectively, and once the protrusions 370, 372 are received within respective openings 241, 243 of the respective connector extensions 240, 242, engagement of the connector extensions 240, 242 by the flat proximal surface 370*a*, 372*a* of the protrusions 370, 372, respectively, prevents the connector extensions 240, 242 from being disengaging from the first pusher assembly 340 during operation of the adapter assembly 300 and the extension assembly 200.

The adapter assembly 300 operates in a substantially similar manner to adapter assembly 100 described hereinabove. In addition, adapter assembly 300 is configured to permit rotation of an end effector, e.g., end effector 30 (FIG. 34) attached to adapter assembly 300 or attached to an extension assembly that is attached to adapter assembly 300 to be selectively rotated about longitudinal axis "x" (FIG. 36) during use.

Any of the components described herein may be fabricated from either metals, plastics, resins, composites or the like taking into consideration strength, durability, wearability, weight, resistance to corrosion, ease of manufacturing, cost of manufacturing, and the like.

Persons skilled in the art will understand that the devices and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary embodiments. It is envisioned that the elements and features illustrated or described in connection with one exemplary embodiment may be combined with the elements and features of another without departing from the scope of the present disclosure. As well, one skilled in the art will appreciate further features and advantages of the disclosure based on the above-described embodiments. Accordingly, the disclosure is not to be limited by what has been particularly shown and described, except as indicated by the appended claims.

What is claimed is:

1. A surgical assembly for operably connecting an end effector to an electrosurgical instrument, the surgical assembly comprising:

an adapter assembly including,

a connector assembly;

a drive transfer assembly operably received through the connector assembly and including a first rotatable shaft; and

a first pusher assembly operably connected to the first rotatable shaft for converting rotational motion from the first rotatable shaft to longitudinal movement to perform a first function, the first pusher assembly including a first pusher member, and first and second pawl assemblies; and

an extension assembly operably connected to a distal end of the adapter assembly, the extension assembly including a flexible band assembly having first and second connector members, the first connector member being releasably connectable to the first pawl assembly of the first pusher assembly and the second connector member being releasably connectable to the second pawl assembly, wherein the first connector member is laterally spaced from the second connector member.

2. The surgical assembly of claim 1, further including a second pusher assembly, and a second rotatable shaft operably connected to the second pusher assembly for converting rotational motion from the second rotatable shaft to longitudinal movement to perform a second function.

3. The surgical assembly of claim 2, further including a drive member, and a third rotatable shaft operably connected to the drive member for transferring rotational motion from the third rotatable shaft to perform a third function.

4. The surgical assembly of claim 1, wherein the first pawl assembly includes a first plurality of pawl members, and the second pawl assembly includes a second plurality of pawl members.

5. The surgical assembly of claim 4, wherein each of the first and second connector members define an opening configured for selective receipt of a respective one of the first and second pawl assemblies.

6. The surgical assembly of claim 5, wherein the first plurality of pawl members includes a first protrusion selectively receivable within the opening of the first connector member, and the second plurality of pawl members includes a second protrusion selectively receivable within the opening of the second connector member.

7. The surgical assembly of claim 6, wherein each of the first and second protrusions includes a flat proximal facing surface and a slanted distal facing surface.

8. The surgical assembly of claim 4, wherein the first and second plurality of pawl members are pivotally secured to the first pusher member.

9. The surgical assembly of claim 4, wherein the first pusher member includes a first retainer for supporting the first plurality of pawl members, and a second retainer for supporting the second plurality of pawl members.

10. The surgical assembly of claim 9, wherein the first and second retainers each define a longitudinal slot for receiving the respective first and second plurality of pawl members.

11. The surgical assembly of claim 10, wherein the first plurality of pawl members are pivotally received within the longitudinal slot of the first retainer, and the second plurality of pawl members are pivotally received within the longitudinal slot of the second retainer.

12. The surgical assembly of claim 11, wherein each of the first and second plurality of pawl members are configured to flex radially inward.

13. The surgical assembly of claim 4, wherein the first and second plurality of pawl members each include a curved profile.

14. The surgical assembly of claim 4, wherein the first and second plurality of pawl members are each formed of a flexible material.

15. A surgical assembly for operably connecting an end effector to an electrosurgical instrument, the surgical assembly comprising:

an adapter assembly including,

a connector assembly;

a drive transfer assembly operably received through the connector assembly and including a first rotatable shaft; and

a first pusher assembly operably connected to the first rotatable shaft for converting rotational motion from the first rotatable shaft to longitudinal movement to perform a first function, the first pusher assembly including a first pusher member, and first and second pawl assemblies; and

an extension assembly operably connected to a distal end of the adapter assembly, the extension assembly including a flexible band assembly releasably connectable to the first and second pawl assemblies of the first pusher assembly.

16. The surgical assembly of claim 15, wherein the first pawl assembly includes a first plurality of pawl members, and the second pawl assembly includes a second plurality of pawl members.

17. The surgical assembly of claim 16, wherein the flexible band assembly includes first and second connector members, each of the first and second connector members defining an opening configured for selective receipt of a respective one of the first and second pawl assemblies.

18. The surgical assembly of claim 17, wherein the first plurality of pawl members includes a first protrusion selectively receivable within the opening of the first connector member, and the second plurality of pawl members includes a second protrusion selectively receivable within the opening of the second connector member.

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